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MR. JOHN VAUGHAN.

MR. JOHN VAUGHAN AND THE PROGRESS OF THE CLEVELAND IRON TRADE.

EVERYBODY who makes any pretensions to a knowledge of what is going on in the commercial world must have heard of Middlesborough. With a rapidity, fecundity, and enterprise equalled only by the marvellous development of transatlantic cities, such as Chicago and Philadelphia, Middlesborough has advanced to the proportions of a large, wealthy, and prosperous town. Grave's "History of Cleveland" speaks of four farm-houses at Middlesborough more than fifty years ago; in 1829 the Middlesborough Estate Owners' Company, of which the late Mr. Joseph Pease, of Darlington, was the principal, was formed for the purchase of the ground now covered by the town that bears its name; in 1830 the Stockton and Darlington Railway—the first passenger railway in the kingdom—was extended to Middlesborough; in 1831 the town of Middlesborough had a population of 134, most of whom were coal-heavers; and in 1850 the population had increased to over 6,000. The present population of Middlesborough is over 50,000, and it is increasing at the rate of 5,000 per annum.

The commercial history of Middlesborough commences with the export of coal about the year 1834, the Middlesborough dock having been opened a short time previously. The district now populated by the teeming thousands employed about the works on the Tees-side was then a "waste howling wilderness," liable to incursions of aquatic fowl. The town that now is was altogether "without form, and void." It remained in this condition until 1840, when Messrs. Bolckow and Vaughan resolved to undertake here the erection of small ironworks. Mr. Bolckow had a capital of some £40,000 to £50,000. Mr. Vaughan could put nothing into the business but his skill and administrative capacity. The two men had come together in consequence of meeting at a friend's house in Newcastle, where Mr. Bolckow had been a corn merchant, while Mr. Vaughan was manager of the Walker Ironworks on the Tyne. They were well fitted to pull together, for Mr. Vaughan had been brought up as a practical ironworker at Dowlais Works in the principality, and had gone through all the various grades of iron working until he attained the apex of attainment; while Mr. Bolckow was essentially a man of

figures, well up in tare and tret, capable of dealing with the minutest fractions, and equally at home on the *pons asinorum* or in the differential calculus. It was a chain of purely fortuitous circumstances that induced the firm to settle at Middlesborough. They had made the acquaintance of the late Mr. John Harris, engineer of the Stockton and Darlington Railway, and he advised them that Middlesborough was within easy distance of the Durham coal-field, and possessed shipping facilities which could be turned to advantage. A small foundry, little better than a blacksmith's shop, had been set agoing at Middlesborough some time previous to the advent of Messrs. Vaughan; but practically it was that firm who gave to the iron trade of the Cleveland district its first impetus.

In 1846 Messrs. Bolckow and Vaughan were induced, by the offer of a supply of ironstone from the coal-fields near Bishop Auckland, to erect four furnaces at Witton Park. Their expectations were, however, doomed to disappointment. The supply of ironstone at their disposal was limited and fragmentary. It happened to the new firm as it had happened years before to their predecessors on the Tyne—they had built without counting the cost, and were nearly ruined in consequence. For a time their prospects were dark indeed. Mr. Vaughan was compelled to run about the country picking up cargoes of ironstone wherever he could find them. With great difficulty they managed to tide over four years with the precarious supplies so obtained, and then came the discovery of the Cleveland ironstone, which proved their salvation.

It is not pretended that the merit of the discovery of the Cleveland ironstone is wholly due to Mr. Vaughan. Mr. Jackson, owner of the Normanby estate, had sent two cargoes of it in 1811 to the Tyne Ironworks. Mr. Charles Attwood, of the Towlaw and Tudhoe Ironworks, had proved its existence in 1830, and had actually made up his mind to investigate its properties, with a view to its development, nearly twenty years before Mr. Vaughan stumbled upon it. But the discovery of the "rider ore" of Weardale led Mr. Attwood to alter his plans, and establish himself in a locality where he expected to be able to make better iron than the ironstone of Cleveland was capable of producing. Again, in 1839 a cargo of the Cleveland ironstone was sent to the Devon Ironworks in Alloa, where it was treated as useless rubbish. When Messrs. Bolckow and Vaughan applied for a license to work the Cleveland ironstone, the owner of the soil told them that he would not consent to an arrangement that was likely to lead to their ruin and the spoiling of his estate. But in the long run they elected to throw in their lot with this despised and rejected material. At Skiningrove, on the coast between Saltburn and Whitby, they found large masses of ironstone lying bare on the surface of the ground, having been loosened from its bed by the disintegrating effects of the weather. These nodulous masses they used in their Witton Park furnaces, until Mr. Vaughan made the discovery that further inland the bed of ironstone thickened out from 4½ ft. to 14½ ft., and contained 31 per cent. of metallic iron instead of 25. This was, indeed, a great discovery, but it did not promise to yield all the advantages sought for. The stone was quite new to the blast-furnacemen, and its reduction was attended with considerable difficulty. Containing a large amount of calcium, it was found almost impossible, upon the first trials, to get the slag to run. In course of time it dawned upon the manager that the Cleveland ironstone required less flux than the claybands of West Durham, and after repeated experiments he found that, after reducing the proportion of flux from 18 cwt. to 9 cwt., the furnaces worked the Cleveland ironstone with the most perfect smoothness and regularity.

This, then, was the real commencement of the Cleveland iron trade. In 1850 Mr. Vaughan, finding that great inconvenience attended the use of such an exposed place of shipment as Skiningrove, sought for the position of the ironstone in the Eston Hills, and having found it, he relinquished the working at Skiningrove and opened out the Eston mines. At Eston the firm acquired a very large royalty at a merely nominal rate. Coal was then also a drug in the market. The firm had everything in their favour—they could make pig-iron, as Mr. Vaughan himself declared, for 25*s.* per ton, whereas it now costs from 50*s.* to 70*s.* per ton to produce Cleveland pig. There was a ready market for their manufacture all over the world. Appreciating the importance of their chance, Messrs. Bolckow and Vaughan determined to erect, in connection with their rolling mills at Middlesborough, three additional furnaces. This they did towards the close of 1851, the new furnaces being put into operation in the course of the following year. In 1853 the firm projected the works at Eston, within a mile and a-half of their ironstone mines, where other three blast-furnaces were built. Since that time the following additional works have been erected, specially for the smelting of the ironstone of Cleveland :—

Year.	Name of works.	No. of furnaces.
1854	Cleveland Ironworks . .	3 furnaces
„	South Bank „ . .	3 „
„	Tees „ . .	4 „
„	South Durham „ . .	3 „
1855	Ormesby „ . .	4 „
„	Port Clarence „ . .	3 „
„	Stockton „ . .	3 „
„	Wallsend „ . .	2 „
„	Felling „ . .	2 „
„	Bradley „ . .	4 „
1856	Norton „ . .	2 „

Up to this time, therefore, the number of furnaces built for the reduction of the ore of Cleveland was thirty-nine. In 1856 the total production of pig-iron in the north of England, including the thirty-seven furnaces built previous to 1851, was 247,500 tons. Comparing these figures with those of the present time, we find a marvellous advance. The following is the latest official return of the number of furnaces built and blowing in the north of England :—

Place and owners.	In.	Out.	Total.
Eston (B. V. and Co., Limited) . . .	7	—	7
South Bank Iron Co.	6	—	6
Clay Lane Iron Co.	6	—	6
Cargo Fleet (Swan, Coates and Co.) .	4	—	4
Normanby (Jones, Dunning, and Co.) .	3	—	3
Ormesby (Cochrane and Co.) . . .	2	2	4
Tees (G. W. P. and Co.)	5	—	5
Middlesborough (B. V. and Co.) . .	3	—	3
Tees-side (H. G. and Co.)	4	—	4
Linthorpe (Lloyd and Co.)	6	—	6
Acklam (Stevenson, Jaques, and Co.) .	4	—	4
Ayresome (Gjers, Mills, and Co.) . .	4	—	4
Newport (B. Samuelson and Co.) . .	7	1	8
Clarence (Bell Brothers)	8	—	8
Norton Iron Company, Limited . . .	3	—	3
Thornaby (W. Whitwell and Co.) . .	3	—	3
Stockton Iron Furnace Company . .	3	—	3
Carlton Industrial Iron Co., Limited .	3	—	3
Grosmont (C. and T. Bagnall) . . .	2	—	2
Glaisdale Iron Company	3	—	3
Middleton (George Wythes and Co.) .	3	—	3
South Durham Iron Co.	3	—	3
Ferryhill Iron Co.	8	—	8
Witton Park (B. V. and Co.) . . .	5	—	5
West Hartlepool (T. Richardson and Sons)	2	—	2
Consett Iron Co., Limited	5	2	7
Jarrow (Palmer's Iron Co.)	4	—	4
Elswick (Sir W. Armstrong and Co.) .	2	—	2
Walker (Losh, Wilson, and Bell) . .	0	2	2
Norwegian Titanic Iron Company . .	1	1	2
Wear (Bell Brothers)	1	—	1
Tudhoe (Weardale Iron Co., Limited).	0	2	2
Lackenby Iron Company	2	—	2
Seaham (Watson, Kipling, and Co.) . .	1	—	1
Tees-Bridge Iron Co.	2	—	2
Coatham (Downey and Co.) . . .	2	—	2
Totals for Cleveland . .	127	10	137

The production of these furnaces for last year was over 1,800,000 tons, or about a third of the total make of the United Kingdom; so that more than a million and a-half tons have been added to the production of the Cleveland district since 1856. To effect the reduction of this mineral output nearly 6,000,000 tons of ironstone, fully 5,000,000 tons of coal, and 1,500,000 tons of limestone are put in operation. This is inclusive of a certain quantity of hematite ore from Cumberland and Spain, which is used in the furnaces of Cleveland. Altogether, over 12,000,000 tons of raw material are necessary to the production of the 2,000,000 tons of crude iron now annually manufactured in the Cleveland district. To this Mr. Isaac Lowthian Bell would add a substance not usually described as raw material, "although in reality as fully entitled to be so classed as the fuel we burn." This is atmospheric air, of which it is calculated that something like 7,000,000 tons are annually driven into a single blast-furnace by the constant exercise of a power equal probably to that of 12,000 horses.

Great as these results undoubtedly are, they are accompanied by others of almost equal magnitude, and of scarcely less importance. The development of the manufactured iron trade follows that of the crude iron trade with almost as much certainty as a shadow follows its substance. In the north of England, at all events, the fabrication of malleable iron has fully kept pace with the production of the crude material. Mr. Isaac

Lowthian Bell has ascertained that the number of puddling furnaces carried on in connection with the Northumberland and Durham coal-field in 1863 was as follows :—

Works.	Firms.	No. of Puddling Furnaces.
Walker	Messrs. Losh, Wilson, and Bell	50
Gateshead	Messrs. Hawks and Co.	33
Consett	Derwent Iron Co.	99
Bishopwearmouth	Ditto	31
Birtley	Birtley Iron Co.	6
Bedlington	Mounsey and Dixon	14
Shotley Bridge	Richardson and Co.	27
Hive, Jarrow	Elliott and Co.	10
Sunderland	Tyzack and Co.	7
Britannia	G. Hopper	16
Jarrow	Palmer and Co.	30
Tudhoe	Weardale Iron Co.	64
Middlesborough	Bolckow and Vaughan	68
Witton	Ditto	71
Tees-side	Hopkins and Co.	56
Albert Hill	Barningham and Co.	45
Stockton	Stockton Iron Co.	20
	Total	624

The annual make of finished iron by these 624 furnaces was estimated at 300,000 tons. Within ten years, however, these figures have been more than trebled. The production of finished ironworks of the north of England is now estimated at over a million tons per annum, and the following table shows the mere use of the works and plant :—

Works.	Furnaces.
Bolckow, Vaughan and Co., Middlesborough	66
Hopkins, Gilkes, and Co. „	84
Britannia Iron Company „	120
West Marsh Iron Company „	20
Jones Brothers and Company „	23
Jackson, Gill, and Company „	40
Fox, Head, and Company „	42
Bowesfield Iron Company, Stockton	38
North Yorkshire Iron Company, Stockton	39
Stockton Rail Mill Company, Stockton	70
„ Malleable Iron Company, Stockton	85
West Stockton Ironworks, Stockton	37
Shaw, Johnston, and Reay, „	36
R. Jacques and Company, „	8
W. Whitwell and Company, „	34
J. Holdsworth and Company, „	21
T. Richardson and Sons, Hartlepool	109
Hartlepool Malleable, Hartlepool	32
Darlington Iron Company, Darlington	190
Fry, Ianson, and Company, Darlington	32
Skerne Ironworks, Darlington	60
T. Vaughan, Whessoe, Darlington	38
T. Vaughan, Bishop Auckland	33
Weardale Iron Company	70
Bolckow, Vaughan, and Co., Witton Park	110
Consett Iron Company	156
S. Tuzzack and Company	32
Ranie Brothers	17
Oswald and Company	87
Palmer's Iron Company	70
John Elliot	10
Losh, Wilson, and Bell	57
Thomas Abbot	20
John Abbot and Company	38
Felling Iron and Coal Company	23
Hopper, Ratcliffe, and Company	41
Hawks, Crawshay, and Company	69
Stranton Iron and Steel Works	20
Birtley Iron Company	6
Total	2,101

So much for the statistical results of the achievements of Messrs. Bolckow and Vaughan. There are other results not less important yet remaining to be considered. Although Mr. Vaughan was a practical ironmaker, he was as new as everybody else to the conditions under which the ironstone of Cleveland could be most profitably and successfully smelted. In Wales, the practice was to use furnaces 40 to 50 feet in height, and Mr. Vaughan did not think himself wiser than the founders and managers of the greatest works in Wales, to say nothing of Staffordshire and Scotland, where the furnaces were carried to the same height. He therefore carried his first Middlesborough furnaces to the height of only 42 ft. with a 15 ft. bosh and a cubical capacity of 4,566 ft. Very little effort was made to improve the construction of the blast-furnaces of Cleveland until, in 1856, Mr. Vaughan rebuilt one of the Witton furnaces, and ventured with some little misgiving to increase its height from 42 ft. by 13 ft. to 61 ft. by 16 ft. 4 in. The results obtained from the larger furnace were so superior to those obtained in its predecessor that Mr. Vaughan at once recommended increased height and capacity in the blast furnace. The following statistical information, contributed by Mr. John Gjers, of the Ayresome Ironworks, Middlesborough, to the transactions of the "Iron and Steel Institute," shows the gradual improvement in the height and capacity of the Cleveland furnaces :—

Date.	Name of Firm.	No. Built.	Height.	Diameter of Bosh.	Cubic Capacity.
			ft. in.	ft. in.	
1851	Bolckow and Vaughan	3	42 0	15 0	4,566
1853	Bell Brothers	6	47 6	16 6	6,174
1853	Bolckow and Vaughan	6	54 0	15 0	7,116
1853	Gilkes, Wilson, Pease, & Co.	2	45 6	14 6	5,100
1854	Cochrane and Co.	4	55 0	16 0	7,175
1854	B. Samuelson and Co.	3	50 0	14 0	5,050
1854	Bolckow and Vaughan	3	54 0	15 0	7,116
1854	Gilkes, Wilson, Pease, & Co.	2	55 0	14 6	6,800
1856	Stockton Furnace Co.	3	50 0	16 0	6,341
1856	Norton Iron Co.	3	50 0	15 0	6,000
1858	Thomas Vaughan	6	56 0	16 0	7,000
1858	Hopkins, Gilkes, and Co.	2	56 6	16 0	7,200
1858	Jones, Dunning, and Co.	0	58 0	17 0	8,000
1858	Bolckow and Vaughan	1	61 0	16 4	7,960
1861	Gilkes, Wilson, Pease, & Co.	1	55 0	16 0	7,700
1861	William Whitwell and Co.	3	60 0	20 0	12,778
1862	Bolckow and Vaughan	2	75 0	16 6	11,985
1864	B. Samuelson and Co.	4	69 0	20 0	15,500
1864	Thomas Vaughan	3	70 0	18 0	12,000
1864	Lloyd and Co.	4	67 0	20 0	15,000
1864	Thomas Vaughan	6	81 0	19 0	16,000
1864	Stevenson, Jaques, and Co.	3	70 0	22 0	17,000
1865	Gilkes, Wilson, Pease & Co.	2	75 0	21 0	17,700
1865	Bell Brothers	2	80 0	20 6	15.500
1865	Bolckow and Vaughan	2	95 6	16 0	15,050
1866	Ditto	1	75 0	20 0	12,972
1866	Hopkins, Gilkes, and Co.	2	75 0	24 0	20,000
1866	Swan, Coates, and Co.	2	75 0	20 0	16,090
1866	Bell Brothers	2	80 0	17 0	11,500
1867	Norton Iron Co.	2	85 0	25 0	26,000
1867	Cochrane and Co.	2	76 0	23 0	20,624
1868	Gilkes, Wilson, Pease, & Co.	1	75 0	24 0	22,500
1868	Stevenson, Jaques, and Co.	1	70 0	23 0	18,000
1868	B. Samuelson and Co.	1	69 0	21 6	16,000
1868	Lloyd and Co.	2	80 0	21 6	18,000
1868	Jones, Dunning, and Co.	3	73 0	18 0	12,000
1868	Bolckow, Vaughan, and Co.	2	95 6	22 0	25,940
1868	Ditto	1	95 6	23 0	28,800
1869	Thomas Vaughan	3	85 0	25 0	26,000
1870	Bell Brothers	4	80 0	25 0	25,000
1870	Stockton Furnace Co.	2	80 0	24 0	24,613
1870	Swan, Coates, and Co.	1	75 0	23 8	22,229
1870	Cochrane and Co.	2	90 0	30 0	41,149
1870	Gilkes, Wilson, Pease, & Co.	2	85 0	27 0	32,000
1870	B. Samuelson and Co.	2	85 0	28 0	30,000
1871	Bolckow, Vaughan, and Co.	2	95 6	24 0	28,950
1871	Lackenby Iron Company	2	85 6	25 6	26,670
1871	Gjers, Mills, and Co.	2	85 0	25 0	26,000

Since Mr. Gjers collated the above figures, still more remarkable advances have been made in the way of increasing the size of the blast-furnaces of Cleveland. Three furnaces have been carried to the height of 103 ft. At the works of the Ferryhill Iron Company, another pair of furnaces now under construction will be carried to the enormous altitude of 105 ft.! Of course, these latter furnaces when completed will be the highest in the world.

Very manifest advantages have followed the increase of height and capacity in the Cleveland furnaces. The consumption of coke has been reduced from 35 cwt. to 23 cwt. per ton of iron made, and the production of the furnaces has in most cases been doubled, or even more. It is calculated that over the whole of Cleveland the improvement has led to an annual economy of over half a million tons of coal per annum. It is therefore no small honour to the late Mr. John Vaughan that his name should be so prominently identified with such a valuable advance in the science of metallurgy.

Next to the increase of height and capacity in the blast-furnace, perhaps the greatest improvement in metallurgical science which Cleveland has inaugurated is the increase of temperature from 300°, which was the limit fixed by the late Mr. Neilson, to 1,400° and 1,500°. The old heating stoves of twenty years ago presented 250 to 500 square ft. of surface for each 1,000 cubic ft. of blast supplied per minute, but it is now quite a common thing in Cleveland to allow 1,250 to 1,300 square ft. Mr. Benjamin Ford, Mr. Thomas Whitwell, Mr. Player, Mr. Godfrey, and other gentlemen have devised different forms of heating stoves, so that there is now a great variety to choose from. The increase of temperature in the blast has been attended with several important advantages, but the economy of coke is perhaps paramount to all others. Mr. Vaughan took a great interest in this improvement, as he did also in that of the utilization of the waste gases of the furnace, which in the earlier history of Cleveland were all allowed to escape from the open top, as they are now in the majority of the Scotch furnaces.

We cannot close this record of the practical and scientific results of Mr. Vaughan's eminently useful life without glancing briefly at the future of Cleveland. There is, perhaps, no district in the world with better prospects before it. Mr. John Jones, the secretary of the Cleveland Ironmasters' Association, has calculated that the main seam of the Cleveland ironstone will last for at least 100 years, even at an increasing ratio of consumption. There are now about 300,000,000 tons leased and unworked, which would give a yield of 7,740,000 tons per annum, equal to thirty-seven years' consumption. In 1871 the total quantity of pig-iron made in the Cleveland district was 1,884,000 tons, representing a consumption of 5,652,000 tons of ironstone. Last year over 1,900,000 tons of pig-iron were made, and the quantity of ironstone raised in the district was about 6,000,000 tons. Mr. Isaac Lowthian Bell has estimated that there is just about sufficient coal in the Durham coal-field, reserving it exclusively for that purpose, to smelt the ironstone contained in the Cleveland hills. At any rate, the prospect is very remote of an exhaustion of the raw materials, while the supply of mountain limestone used as a flux, and obtained in the Weardale district, is practically inexhaustible. With these splendid natural resources at their disposal, the ironmasters of Cleveland have every encouragement to exhibit all the energy and enterprise of which they are capable. At the present moment they are in the thick of "enterprises of great pith and moment." The introduction of Danks' rotary puddling furnaces has commenced a revolution in the manufactured iron trade, and it is generally believed that the days of hand puddling are numbered. The Erimus Works, between Middlesborough and Stockton, have been built for the purpose of testing the Danks principle on a large scale. These works are now in operation, having been started about a fortnight ago; and if the results which they yield are such as the promoters expect, the old reverberatory furnace will go to the wall very fast. There are other forms of the puddling furnace now being tried at different works, which are likely, apart from the Danks system altogether, to lead to a great economy of fuel, and for which other advantages are claimed. It is the destiny of Cleveland, to all outward appearances, to devise and put into practical operation ways and means of saving the great waste that is admittedly allowed to take place in the ordinary puddling furnace—a waste which involves a loss of calorific power equal to at least 90 per cent. There is also a strong probability of steel making being added, in course of time, to the industries of this great district. Hitherto all attempts to manufacture Cleveland steel from Cleveland iron have been attended with failure, owing to the vitiating elements with which the iron is impregnated, and especially because of the presence of one to one and a-half per cent. of phosphorus. The superior quality of iron obtained from the Danks process is now likely to suit the requirements of steel making, and experimental trials are now in contemplation, with a view of ascertaining the practicability of producing steel from the iron of the Middlesborough district. As a necessary corollary of the extension of iron-making operations, a very great development of mining industry has taken place. In the year 1850 the annual yield of the Durham and Northumberland coal-field was about 14,000 tons, and of this large quantity ironmaking purposes would absorb fully one-half. Last year the total output of the Durham and Northumberland collieries was about 30,000,000 tons, so that the production has been more than doubled in about twenty years. Fuel, from being, as it was in 1850, a drug in the market, has come to be in very great demand. Coal was then sold at 2*s.* 6*d.* per ton and coke at 6*s.*; but now it is impossible to procure good average coals under 17*s.* per ton, and coke cannot be had under 30*s.* Alongside the iron trade proper, other industries of a collateral nature have recently sprung up. Among these, shipbuilding is entitled to take the first place. On the Tees, the shipbuilding trade has more than trebled in extent and value within the last twenty years. The same remark applies with even greater force to the Wear, and with almost equal appositeness to the Tyne. At Middlesborough a bolt and nut factory, chair foundries, cut-nail works, chemical works, pipe foundries, and engineering establishments are all in active operation; and other industrial ventures new to the district are at present in contemplation.

These are the major results of the enterprise in which Mr. John Vaughan and his partner embarked less than twenty-five years ago. Of Mr. Vaughan's personal and domestic history we have left ourselves little room to speak, having subordinated that part of our narrative to the great work with which his name is so prominently identified. Born at Worcester, on the 21st December, 1799, Mr. Vaughan was the son of a Welsh ironworker, who had long been employed at Sir John Guest's ironworks at Dowlais. When he was old enough to enter the mill, John became an ironworker like his father. He stayed at Dowlais until he received a managerial appointment at a small factory in Carlisle, and from thence, in about three and a-half years, he transferred his services to the Walker Ironworks on the Tyne. It was here, as we have narrated, that he became acquainted with Mr. Bolckow, his future partner, and it was from here, in 1840, that he proceeded to erect the Middlesborough Works.

Mr. Vaughan died in 1868. Towards the latter part of his life he suffered from bad health. He was twice married, and his family consists of only one son, Mr. Thomas Vaughan, of the Clay Lane and South Bank Works, Middlesborough.

Shortly after Mr. Vaughan's death, his bust was placed in the hall of the Middlesborough Exchange; and last autumn a committee of ironmasters was appointed to take steps for establishing a suitable memorial to perpetuate his memory.

J. S. JEANS.

THE ROUVENAT JEWELLERY FACTORY.[1]

ONE of the first to apply the practices of modern industry to the manufacture of jewellery and trinkets was M. Rouvenat. In his workshops the whole succession of operations—excepting only enamelling and engraving—which are necessary for the complete perfection of the jewel or the trinket, are executed. For the first time a space sufficiently large, if we consider the nature of the industry, has been placed at the disposal of the workmen, hitherto crowded together in shops of small dimensions, and executing individually one or many phases of the jewellery manufacture. To his workshops the gold and silver come in ingots, the stones in a rough state or on paper, and yet from his factory all the articles are turned out completely finished, even to the very jewel-boxes in which they are packed. We can, then, in the workshops of the Rue Hauteville, study every detail of this little-known and yet most interesting industry.

Our ancestors, in their classification of the various crafts in the state, drew a marked distinction between the lapidaries, the jewellers, the stone-setters, the goldsmiths—which latter they subdivided into workers in rough gold (*orfèvres grossiers*), workers in planishing gem-gold (*orfèvres-bijoutiers planeurs*), gold wire-drawers, and gold-beaters (*tireurs et batteurs d'or*)—and we find that no one was able to unite many of these professions together. To-day all this is changed; thus M. Rouvenat, whose profession, properly speaking, is jewellery—that is to say, the fabrication of articles in which diamonds are an essential element—at the same time turns out large quantities of sets of ornaments in cameo, in coloured stones, in gold, enamelled or plain, and even enters into the goldsmith's domain in making cups and mirror-frames, sword-handles, ornamented sometimes with precious stones, oftener of metal simply, more or less elaborately worked—in short, all the objects of art composed of the precious metals, ornamented or not with precious stones.

Having under his hand both the designing and the working, M. Rouvenat is able to conceive and to execute particular and individual designs which recall the labours of the ancient jewellers, and are altogether out of the ordinary routine of the productions of current industry. While continuing to work as a manufacturer for merchants, and intermediaries, and middlemen, foreign as well as French, he has been able to directly establish with the general public relations that in this trade are very uncommon. Anyone having a wish for a special kind of trinket has only to draw the design and forward it to M. Rouvenat, who, in carrying it into execution, will manufacture an

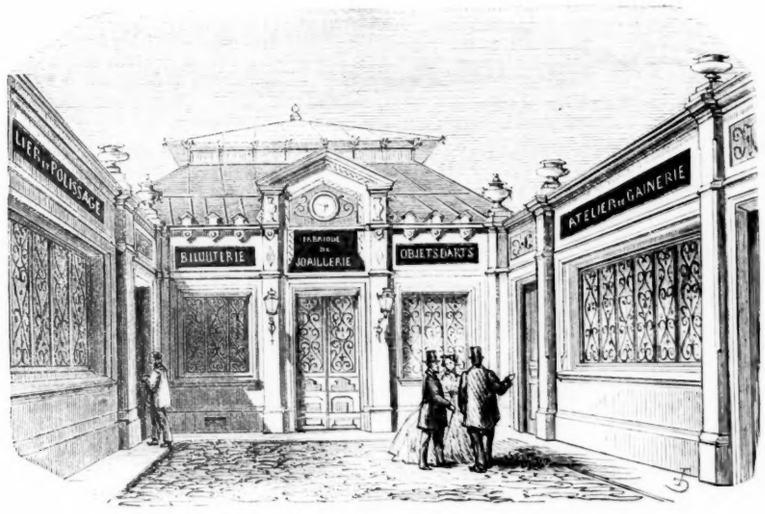
[1] From "Les Grandes Usines," by M. TURGAN.

object which cannot, like the ordinary and vulgar forms belonging to the trade, be found in any jeweller's shop whatever. We approve heartily of this manner of acting, for, according to our ideas, gems and trinkets, which are often presents, should affect some individual form, almost unique; and there is certainly something displeasing in seeing the counterparts of these cherished objects worn by others.

Many people, too, without extending their susceptibility so far, still prefer what they call novelty to the forms a long time in use. To satisfy this taste, M. Rouvenat is incessantly ingenious; he designs especial and novel models, invents combinations of stones and metals, and, through skill and sheer labour, has at length attained a grand place in his profession.

From all time the love of ornament has called into existence a variety of little articles designed to be worn or carried either in the hand, or on the neck, or in the ear, or in the hair. Flowers and leaves and brilliant grain-seeds were the first adornments. To these succeeded the metals, especially gold and silver, as more unalterable than the others, originally in a primitive condition, then very roughly worked. In the measure that civilization developed, the trinket became more and more complicated; it was not only an object of simple ornamentation, but it nearly always bore with it an idea moral or religious, sometimes even political. The rings of the Roman knights, the gold balls of the young patricians, the necklets of the Gallic chieftains, were all veritable marks of distinction; the statuettes —more or less decent—of the Pagan gods; later on, the chaplets, beads and crosses, and the talismans of the East, gave the trinket a kind of religious importance; the chains recalled slavery, the bracelets war, the clasping-hands fidelity, other images love and Hymen;—even to-day there are very few articles of jewellery which are not meant as presents, either as adornments for the wedding outfit, or as rings of betrothal, or for all those charming nothings which are given by one person to another on fête-days and anniversaries, as a pledge of sympathy, and as *souvenirs* by those who have among themselves some bonds of family and affection. For some few, now as formerly, the jewel or trinket is a pretext for the accumulation of wealth. The nations least civilized and polished make their chaplets of sequins and piastres; and, in some countries, the young maidens carry on their persons in plates of gold the dowry which will follow them even to the tomb; the Greeks and Romans also buried their dead with all their jewels, but as they noticed that this practice led to the violation of the sepultures, they invented imitation articles, so as to bury in the earth only the similitudes of the veritable ornaments.

All those Greek or Roman jewels of which the Campana Museum and the Cabinet des Médailles possess the precious remnants have such an artistic character of the various epochs, Phœnician, Egyptian, Assyrian, Greek, Corinthian, and Etruscan—that it is almost sufficient for us to severally copy them to obtain our grandest efforts. From these sources, indeed, our jewellers have well known how to draw inspiration, and while imitating the form, to add the further charm of superior execution. Nearly all these trinkets are made simply of gold, very few of silver; their principal value lies in the sculpture and chiselling, often of marvellous perfection. The ancient trinkets very rarely carried stones. Enamelling alone was employed, and also stones very little esteemed at the present time, such as the jasper, the agate, the sardonyx, the cornelian, the lapis lazuli, almost always worked as cameos; as to the amethyst, the topaz, and the aquamarine, they were always engraved, and with a perfection which we can scarcely now attain. Among stones that are at present held as precious, the garnet and the emerald were alone admitted, and then only as *cabochons* (stones polished but not cut), full of flaws. Still the Greek world and the Roman had much love for pearls, for which they paid fabulous prices, and some of which, as those of Cleopatra, have became legendary.



THE ENTRANCE TO M. ROUVENAT'S FACTORY.

Nothing now is known of the various processes of work employed by the jewellers of these epochs, but the details of each object are of a taste and an execution truly marvellous; the ornaments and the statuettes which are grouped around necklets, the ear-rings and the diadems, the leaves of the olive and the laurel, the ivy and the vine, which are all used in the coronals and crowns, are copied from nature with infinite art. The *coiffures* of diamonds or stephanatos, the hair-pins whose closed bud contained perfume or even poison, were surmounted with fantastic ornaments, or with the figures of animals, or with statuettes most often representing the gods, especially Venus and Cupid. In the same way, there were necklets which bore in their midst a larger and more characteristic figure.

Sometimes the ancient trinket, as even now-a-days the oriental trinket, received engraven formulæ, prayers, exorcisms, or even the prescriptions of physicians. There were stones good against cholic, against drunkenness; among others the amethyst, chosen always, says M. François Lenormand, by the engravers to receive the figure of Bacchus. The emerald bore specially the image of Venus, and was considered as a love talisman—a reputation it preserved even to the middle ages. And actually to-day the turquoise and the coral are held to carry happiness, while the opal has the contrary reputation; and yet the only true misfortune that can happen to the opal is a fall, in which case it cracks or breaks.

The jewellery of the middle ages was almost entirely swallowed up by the goldsmiths. The victorious barbarians seemed to give a preference to objects rude and solid, and in the writings preceding the sixteenth century we hear always of goldsmiths, and not of jewellers, when mention is made of the precious metals or precious stones; then, however, as in all times, men and women wore articles of gold and silver enriched with stones of a greater or lesser value.

The sentiment of Christianity was little favourable to personal luxury, but developed, on the contrary, a taste for rich ornamentation in all the instruments of worship; the shrines, chalices, the light-holders upon the altar, concentrated almost all the gold, while the silver and precious stones remained buried in the treasure-vaults of cathedrals and abbeys, until the religious wars once more brought them forth.

The goldsmiths of Tourraine had a great reputation, especially after the manufacture of the famous shrine of Saint-Martin, executed by André Mangot to the order of Louis XI. In spite of this special employment of the precious metals, there are, however, a few records of individual ornaments; Agnès Sorel, Charles le Téméraire the Duke of Anjou, and Anne of Brittany, were known for their rich display of jewels. It was the custom, fashionable as far back as the time of Louis XI., to wear in the cap what was termed an "ensign," oftenest an image of a saint, like the leaden Notre-Dame of Embrun, to which the king paid his devotions; they also fastened on the cap medallions, golden buckles, and even diamonds.

Francis I., fastidious as he was in everything, carried to the extreme the love of ornament for himself and his surroundings; in certain circumstances the ladies of his court loaded themselves with such a weight of gold and precious stones that they could scarcely walk, which actually happened to the Duchess of Clèves on her marriage day. The sojourn of Benvenuto Cellini put the crowning height to this exaggeration; goldsmiths, gem-workers, jewellers, and enamellers occupied in the reign of this prince a recognized position in the state, and the names of the artists of that period have been registered in history. Henri III. and the Valois continued these traditions, Henri III. himself especially being often covered with pearls and diamonds. Tours and Paris maintained during the whole of the period a marked pre-eminence in the execution of ornaments and goldsmiths' work. We know very little of the jewels of the middle classes (*la bourgeoisie*), but the portraits in the museums, and the historical memoirs of the time of the Renaissance and the Ligue, with their happy and gossiping descriptions, furnished numerous indications, which were resumed with great talent by M. Paul Mantz in a series of articles published in the *Gazette des Beaux-Arts*.

Gabrielle d'Estrées and Marie de' Medici lent their protection to the ingenious artists who mounted jewels and precious stones for them. Among their jewellers the two Lesgaré are the best known; Gédéon and Laurent Lesgaré published a book of designs, a union of figures and models, under the title of "Livre de Feuilles d'Orfévrerie;" Jacques Gaillard and François Lefèvre composed other designs of an extreme complication, where golden leaves and flowers, butterflies, and precious stones, formed magnificent bouquets.

Starting from the time of Louis XIII., the diamond rivals the pearl in all descriptions of royal feasts and of political interviews. Mazarin, who loved diamonds so well, and who has left such fine specimens in the crown of France, never himself wore any, but kept them shut up in his coffers; but Anne of Austria, on the contrary, covered her robes with them, and all the portraits of the time of the minority of Louis XIV. have preserved for us the memory of the rich adornments worn by the ladies of the court and of the Fronde.

The young king sparkled and glittered with the stones upon his person, with them he loaded even the bridles and saddles of his horses. At the commencement of the reign of Louis XIV. a Lesgaré was again the fashionable jeweller; like his namesake, he published a book, which he called "Des Ouvrages d'Orfèvrerie." The king setting the example, was scrupulously followed by the courtiers, who ruined themselves by their outlay in adornment. Thus the art was originally perfected in France, and the revocation of the Edict of Nantes, which drove a number of skilled workmen from the kingdom, scattered the love and use of beautiful things through all the neighbouring countries.

The age of Louis XIV. was as distinguished and brilliant for jewellery as for the other arts; it was in this reign originally that they discovered how to conceal portraits in a trinket, a medallion, a cane-handle, a watch, &c., which led to a mutual increase of both trinkets and portraits. The journals at the close of the seventeenth century are full of descriptions of pearls and diamonds which to-day appear to us very exaggerated; we are tempted to believe that people did not yet know how to distinguish between the true stones and the false, and that the industry of imitation, while developing in the trade, found clients and supporters among the wealthiest and the noblest. The "Book of Addresses" of Abraham du Pradel, quoted by M. Paul Mantz, teaches us that in 1691, "the false pearls, with silver placed beneath them, which are a new invention, and a perfect imitation of the real pearls, may be purchased in the rue du Petit-Lion;" and this though a decree of more than one century's standing had forbidden the trade in false stones. The romances of the eighteenth century are very fertile in their histories of diamonds of the value of a thousand pistoles, at first true, then false, or *vice versa*, as in all the memoirs of the time. The diamond appears at this period to have constituted a sort of superior money, very handy for gamblers and politicians, for travellers and warriors. The beaux and dandies ofttimes received them from their lords and ladies, and after having decked themselves out for a little brief display, lost them at the basset-table, or sold them without any scruple.

Under Louis XIV. the practice of taking snuff created a new trinket, and the snuff-boxes of gold enriched with diamonds, framed around the portrait of the sovereign, began to appear in the recitals of diplomatists and historians.

The reign of Louis XVI., or more justly speaking, the age of Louis XVI., the grandest epoch in human life for all those artistic and industrial productions which have to-day acquired so high and elevated a value, saw the birth of many admirable creations of a kind absolutely new, and altogether original. Precious stones played here a very small part; the metal admirably chiselled, underlaid with ornaments of coloured gold, very rarely enamelled, composed almost entirely those seals, cane-heads, knife-handles, medallions, watch-cases, eye-glass frames, sweet-meat boxes, caskets, waist buckles, and shoe buckles, snuff-boxes, and those other wonderful objects of which the rare specimens that escaped the disasters of the Revolution are still the pride and the glory of French goldsmith's art.

After the year 1780 the diamond appears to have been concealed, and by degrees to have disappeared; and the famous necklace seems to have snared and tempted Marie Antoinette as much by its great value as its great rareness. Already the first symptoms of barbarous days were evident, bidding the owners of valuable jewels to send them away to foreign countries, or at all events conceal them somewhere. In a short time, all had either disappeared, or were willingly or unwillingly placed on the altar of the country. In a few years, however, the women began to wear some trinkets with a political signification, so far indeed, as to use little guillotines as ear-rings; swords of honour and military insignia quickly followed.

During the Directory diamonds re-appeared, being worn even on those parts of the body where they had never before been commonly seen. They wore them on their arms as bracelets, and on their toes as rings; but they were quickly exchanged for the cameos brought back by the victorious army from Italy, which were peculiarly suited to the classical ideas of the time. Under the Empire the jewel trade retook all its vitality, but not again with the exquisite taste of the eighteenth century; the dull, heavy forms, after the general style of the epoch, were little calculated to produce masterpieces. The Restoration at first followed the errors of the Empire; but, dating from 1630, a reaction slowly commenced, and they begun to seek models for imitation in the bygone centuries; the material execution was better and more cared for, and M. Fossin, a man of the highest merit, created quite a revolution in his art. Side by side with really admirable jewellery they began to manufacture, especially at Paris, considerable quantities of trinkets intended for the export trade; sometimes these were of a taste and a quality more than doubtful, but they always possessed, in some degree, the gift of pleasing, and, above all, the capability of being sold and scattered in considerable numbers.

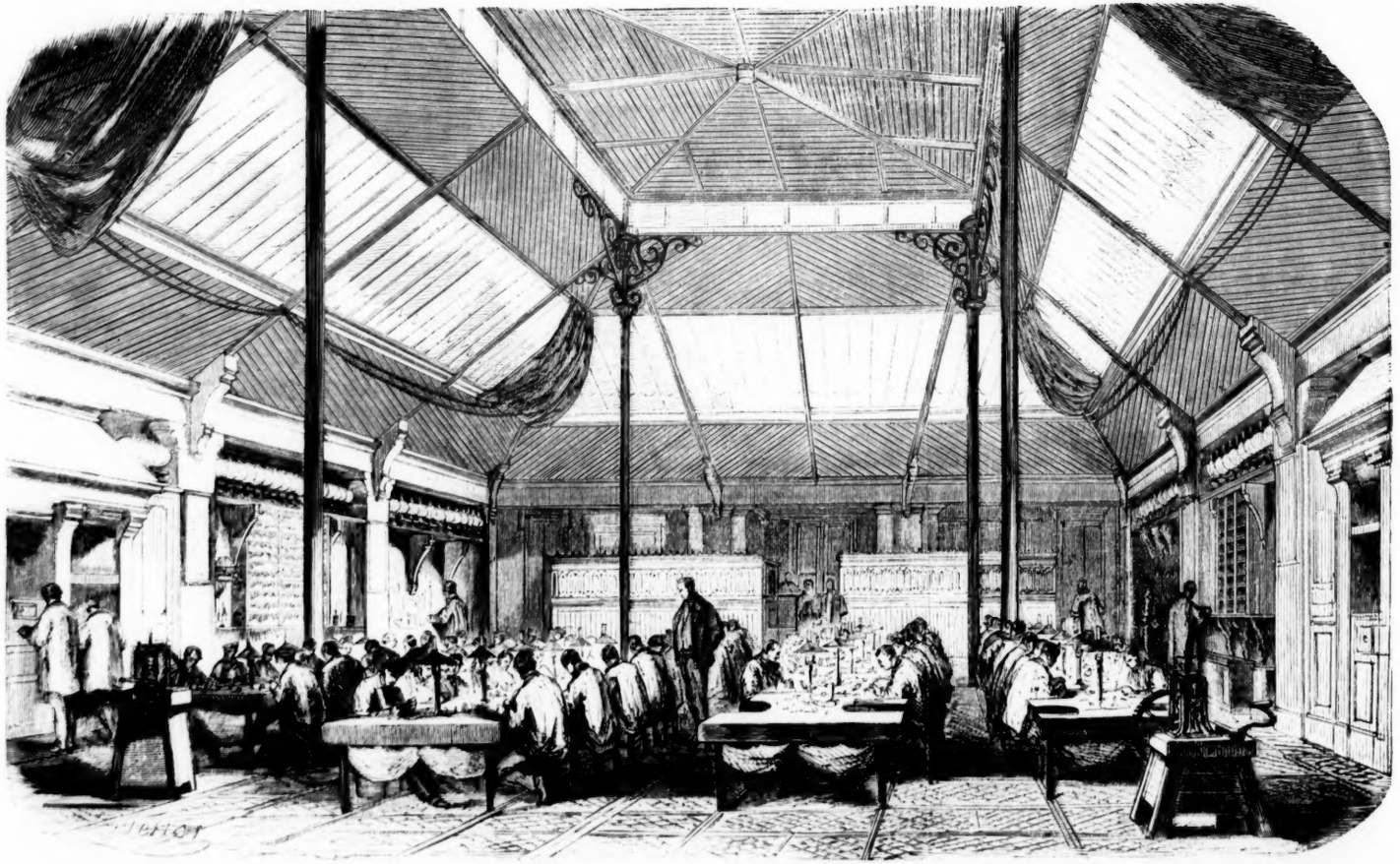
To-day this so-called export trade has been again included in the general manufacture, and since the railways and the love of travelling have brought such crowds of strangers to Paris, these latter have taken our manner of looking at things, and we in return have accepted some of their fantasies, from which has resulted an almost absolute uniformity at first in appreciation, then, and consequently, in manufacture. French jewellery and French trinket-making have made so grand a progress, the gold employed (standard 747) is so justly esteemed, that this industry has attained an annual production of about ninety-six millions of francs, out of which the gold and silver used account for some sixty millions. It is impossible to calculate the value of the diamonds, pearls, cameos and other stones; and the balance of the sum may be written off for workmanship.

We could easily enough develop our subject and write volumes upon the moral, historical, and artistic sides of trinkets and jewellery; but we must now occupy ourselves, above all else, especially with their manufacture.

Before the invention of regular diamond-cutting, the stones played a very restricted part; but from the time of the seventeenth century, the art of dressing precious stones, especially the diamond, has day by day become of vaster moment. We have already shown, in describing the diamond-cutting works of M. Coster at Amsterdam,[1] how this dearly-prized stone is prepared in the form of brilliants or roses, we are now going to see how the stones can be fixed in gold or silver so solidly that they cannot escape from the setting, while being apparently to the eye so nearly free that they can receive the luminous rays after having refracted them in lights of many colours.

Before commencing to make a jewel it is first necessary to

[1] A translation of this interesting article has already been printed in the "Practical Magazine" for last August (No. VIII.)—H. C.



THE CENTRAL WORKSHOP.

decide the volume and the weight of the stones of which it is to be composed, calculating the value at which it is to be sold, and consequently drawing the design in such proportion that all these conditions may be preserved. They then select the stones, paying a special attention to choosing those as nearly alike as possible in colour and quality, and pointing out in each stone the part or parts that should be concealed, or when, at all events, the faults should be toned down by a certain position in the setting, while another position would magnify and exaggerate them. To obtain an approximate idea of the effect that will be thus obtained, they stick the diamonds, after the outline of the design, upon a little plane surface covered with wax; after this trial the workman changes, if it be necessary, some stones for others, or oftener turns the facets until the best position for the emission of the rays of light is obtained.

If a stone is still wanting to thoroughly complete the perfection of the set, he has recourse to the agents or brokers, generally women, who go about to the principal merchants in search of such and such a lot of diamonds, classified by weight and colour; these the merchant trusts to the intermediary, who brings them to the workmen, who is thus able to find the exact stones his set stands in need of.

While one man is thus occupied with the diamonds, other special workmen make ready the gold or silver to receive them. There is a fashion, too, in the choice of these metals, and for some years gold mountings only were in demand, on the pretext that silver became blackened through the influence of gas-light. At the present time the general taste has reverted to silver mounts, because it is supposed that a silver setting is a guarantee for the whiteness of the stones; and, justly or unjustly, white diamonds are preferred to those which are more or less tinged with yellow, though these latter have very often a greater brilliancy.

The gold or fine silver which is brought to M. Rouvenat's factory is first reduced to the requisite standard; that is to say, they add as much copper as is necessary to reduce it to a standard of 747 grammes; this operation should be performed in such a manner as to leave a little excess of the precious metal; the assayers are rigidly severe, and if the tolerated margin of ·003 be surpassed, the jewels will be mercilessly broken on the day when they are carried to the *Contrôle* office to receive the stamp or hall-mark which guarantees their composition.

It is above all essential to pay the greatest attention when the crucible is filled, not with ingots of fine gold or fine silver, but with broken fragments of old trinkets, from which the stones have been taken out, and the solder of which always contains a certain quantity of base metal. This reduction to the standard

SAWING OUT THE SHAPE.

is made in crucibles in the reverberatory furnace, and the molten metal is poured into small ingot moulds, from whence it issues in little bars of gold or silver, with which they can make the plates thicker or thinner according to the work from which many kinds of ornaments are cut out; certain forms may, however, be cast in moulds, but as soon as they are taken out they have to be finished off with the hand.

Nothing is stranger for an outsider than the whole aspect of a jeweller's workshop; gold and silver are regarded by those working them precisely as iron or steel are looked upon by a locksmith or a cutler. Without any respect to the money value, they must needs file, cut, twist, melt, and carve the gold and silver, exactly as if they were working with the common metals.

We can never see without a feeling of lively surprise the off-handed manner in which they handle these precious materials, which, once in the jewellers' shop windows, are regarded of so great a value; the articles are, moreover, very dull and unsightly until they have received the finishing touches. They say, however, that the boarding in the workshops is covered by screens, which retain the dust and the particles detached by file or brush; this powder, gathered with great care, is washed in felt-filters, and a quantity of gold, amounting to a considerable figure, is regained, other precautions are taken to recover all the scraps or particles of gold that are cut away by the tools. The workmen's bench slopes down in such a way as to project under the table itself, beneath which, and as a continuation of the table, a huge leather apron falls over their knees, being fastened to the upper region of the sloping bench. In spite of these precautions, they cannot exactly calculate the absolute loss of the metals which escape without ever being again discovered.

When the gold has been reduced to the standard, which process is never executed by the jeweller himself, but in some special house, as that of Madame Lyon Allemand, it is well hammered either in the same bulk, or is enlarged; it is then rolled out to the desired thickness; after seven or eight passages through the mill, the metal is again placed in the fire, and thus the sheet attains an almost infinite fineness, especially that which is to be stamped or cut out. The stamping is executed with a driver, by means of steel matrices engraved with the burin.

When, on the contrary, the jewel has to be made of full and solid gold, the sheet—in this case much thicker—is not stamped out, but cut and fashioned by every possible means. The first cutting tool is a fine saw, securely fixed at one extremity, and easily detached in the lower part. With the drill or borer they pierce at first a little hole, through which they pass the blade of the saw, which is then fastened to the handle; the tracing designed upon the metal plate is followed out, and the metal is roughly cut.

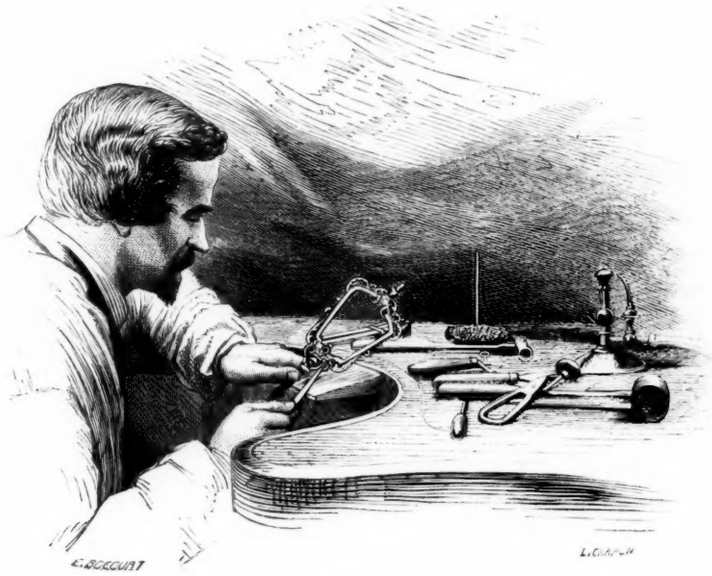
All the imperfections are then repaired with the file, which in jewellery and trinket-making performs a continual part; each workman has a case containing a complete collection of all sizes and all degrees of fineness. With the series of files, all the

superfluous matter is removed ; then the grooves and hollows are made with a kind of square graver, which they call an *échoppe*, a professional tool, and which we shall often see again. During this time the piece is held by a pair of flat or round sliding pincers, or in small or larger vices, fixed or movable, according to the dimensions of the article in course of manufacture.

The piece then begins to take its form ; often it is very difficult and delicate work to hold it with the hands, and in order that it may be worked at all, much ingenuity has been brought to bear upon the different manners of fixing it. As we said before in speaking of diamond-cutting, one of the best methods is to paste up the object, after heating it, in a mastic of resin and powdered brick at the top of a large ball of lead or cast-iron, which, when on a flange, can be readily turned in all directions. When the object is fixed in the cement, they are able to submit it to all the rubbing, filing, and graving, &c. necessary for its transformation ; and it can be held in the same manner for chiselling and engraving, and for the preparation at certain places of the holes destined later on to receive the stones. Finally, to smooth down the ridges and edges which project overfar, they employ a thin slab of a kind of whetstone or a sort of brick composed of Naxos emery, blended with a kind of lack mastic, which is extremely hard. On this dressing-stone the object is gently rubbed, and all the irregularities are removed, the gold that remains sticking to the dressing-stone being readily detached with a brush, and falling into the workman's flap or apron. To produce calottes, or raised surfaces, they employ a kind of bronze thimble-die, a cube of about seven centimetres round ; through all its sides semi-spherical holes have been hollowed out, and in the cavities the smooth and even article is stamped with a *boutterolle* (or punch), a bar of iron widening at one end. The rounded end of the *boutterolle* has to enter into one hole of the thimble-die, and as these holes are of increasing dimensions, it is necessary to have as many punches as there are holes.

The cylindrical portions are made of gold-wire, passed through the drawing machine, and brought by slow degrees to the desired diameter ; with these threads they make chains, larger or smaller as requisite, the forms and arrangements of which, infinitely varied, are sometimes so elaborate as to be broad plaits, almost wove work, of fine gold wire.

For some portions of the object, or even for the entire object, such as the famous peacock exhibited in 1870 by M. Rouvenat, they use a mould, casting the golden article as though it were of bronze or iron. They commence by preparing a wax mould, supported outside by an iron-wire skeleton, and modelled with every possible care and skill. The smelter takes the impression in sand, and as a first trial, fills with brass or copper ; this first



FILING.

proof is then worked and chiselled, all the unevenness being removed, for the hollows are always a little clogged with the sticking of the wax.

The proof thus serves as a good crucible into which the precious metal, either gold or silver, may be cast ; they thus obtain veritable objects of art, which are finally touched up by the sculptor, and so receive their last improvements. By no other means could the body of the peacock, or the humming birds, which attracted so much notice at the Champ de Mars, have been executed with that accuracy of form and detail. They were cast solid, and afterwards hollowed out to lighten them, and make room for the springs that rendered them oscillating and caused the stones with which they were adorned to tremble, sparkle and glitter.

This casting of the precious metals is not sufficiently practised to render it necessary to set aside a chamber for the foundry ; and, when M. Rouvenat wishes to cast, he sends the work to a neighbouring establishment.

The operation in commonest use in the manufacture of trinkets and jewellery is that of soldering ; in fact, to fasten together the two shells of a stamped-out trinket, to form a ring, or to join the different parts of any trinket end to end, you are compelled to solder them one to the other.

Torsion and fettling would not suffice for the quantity and the diversity of the forms executed. Only fine gold could be welded, and then only at a risk. They are obliged to add, then, to the extremities of the two surfaces, a little of the solder, that is to say, an amalgam of copper or silver, which, according to need, is more or less soft.

This solder is prepared in little links which are taken at the end of a pencil, which has first been moistened with borax diluted with water. With the extremity of the pencil the workman penetrates into the tiniest crevices, and then deposits the little fragments of solder.

When a piece has to go to the fire several times they begin by the strong solder and end by the weak, that is solder containing the most silver.

The processes for melting solder vary according to the size and nature of the piece at which they are working. The heat was formerly produced by a forge fire, or by a blow-pipe with bellows passed over an oil lamp. With M. Rouvenat the heat is obtained by the application of gas; and the arrangements devised for this object in the organization of his workshops are altogether special and very ingenious. If the pieces are large, and have to be strongly heated, they take them to a dosser, under which is passed a bellows blow-pipe on the gas, which is admitted by turning a tap as it is needed. The same tap turned off to a marked position allows just that quantity of gas to pass through sufficient to keep a little flame alive, so as to save the trouble of continually relighting it. As the flame from the blow-pipe directed on a single object did not produce a sufficient accumulation of heat to smelt the solder, they bethought them

of forming packets of iron wires, pressed one against the other, to which they connect the object to be heated; then blowing the flame upon this bundle of iron wire, the metal rapidly becomes red-hot, and the solder, too, is soon melted; as soon as the worker judges that the operation is complete, he turns the tap off again to the minimum, so as to avoid all waste of gas. As iron is a very good conductor, the red-hot portion rapidly cools, and they are soon able to detach the soldered object.

There are, however, many pieces which cannot be connected with the iron wire of the heat accumulator, on account of their form or their dimensions; to solder these they have prepared a large cake of powdered charcoal, jammed and fastened into a plaster case. With cramps the object is fixed upon the charcoal, and the flame from the blow-pipe is applied. The charcoal becomes almost instantaneously red-hot, and the object is soldered with extreme rapidity.

But this passing to and from between the work-bench and the forge would waste much time if these processes were not reserved for those pieces only which require an intense heat. In order that the workmen may not have to undergo these perpetual disarrangements in a series of operations which at every moment require a new soldering, M. Rouvenat has erected before each one of them a little jet of gas, always alight, the flame of which they can augment at pleasure by turning a tap. A little bundle of iron wires, like those at the forge, only much smaller, is fixed in front of the gas jet, and upon the heat accumulator the workman can at any moment place his pieces or his portions of pieces; each man has before him a number of these accumulators of various sizes, which he holds in the hand and presents to the flame. In certain special cases, the little fragments of metal, rings, collets or what not, which could not be fastened to the iron wires without great difficulty, are fixed with cramps upon a small piece of charcoal surrounded with a plaster case about it. With an iron tube slightly bent at its extremity, the workman himself blows as hard as he can, and at the same time directs the flame. Whenever it is possible to execute several solderings at once, the pieces are made ready for that purpose; and sometimes they are able to perform as many as twenty operations simultaneously. Sundry very complicated objects require, however, as many as a hundred solderings.

After having been heated, the piece is almost always again treated with the file, the chisel, and the graver.

These operations do not follow one another, but they are repeated and intermixed incessantly; the workmen continually run from one to the other; thus a workman's table is always covered with tools, which he uses at every instant: saws, pincers, files, gravers of all kinds, brushes, hammers, and mallets for smoothing, and dressing, and cutting.

SOLDERING WITH THE BLOWPIPE.

In boring holes—an operation still very frequent in jewel making—they use a kind of violin-bow, of which the handle is of bone and the string of gut, fitted with a spiral twisted round it of very fine iron wire. This string or cord is rolled round a little pulley, from the centre of which starts a very sharp and hard boring bit. Fixing the pulley on one side, and on the other the object that has to be pierced, they move the bow backwards and forwards, and thus a rotation, quicker or slower, is established, which very soon bores the required hole. Another more powerful instrument, at present peculiar to jewel manufacture, and which might be applied to other arts, is the drill. This very elegant and most ingenious tool is composed of an axis and an iron rod, at the end of which is a borer. The axis crosses a lever, from the two extremities of which an eel-skin band is directed triangular-wise to the upper end of the rod. Between the handle and the borer a brass collar or groove exactly perpendicular to the axis moves as a fly-wheel. To make use of this instrument, the workman begins by fixing upon a stout wooden peg coming out from the table in front of him the piece of metal in which he intends to bore a hole, then, holding the handle of the drill in his right hand, he moves it up and down with the speed that his judgment recommends. The rolling and unrolling of the eel-skin band determines the rotation, increased more and more rapidly, and augmented by the groove employed as a flying-wheel. Very great skill is required in using the drill; any inattention would be dangerous, especially at the moment when the borer is withdrawn from the hole, for the rod might easily descend and seriously wound the left hand of the operator.

When the article in course of manufacture is not intended to carry any stone, nothing more is left but to clean it with diluted sulphuric acid (*dérocher*) before the polishing takes place, or before it is coloured, from which latter process it takes the appearance of either fine gold or of one of the many blendings of gold. This washing is intended to free the trinket from all mischances caused by soldering and by the various processes of handiwork which have been employed to bring it to its last perfection. The cleansing is executed by plunging the article into a boiler or stew-pan placed atop of a furnace, and boiling it there for some seconds; this boiler or stew-pan contains a mixture of water and sulphuric acid, which takes off the slightest trace of borax or dirt. Coming out of the boiler, the trinket is washed in pure water. If it has now to be coloured it is necessary at first to compose a "sauce," or mixture of salt, saltpetre, and alum, to which is added chlorhydric acid. When all the salts are well blended and melted, they hook the trinket that has to be coloured to a glass stick with a piece of platinum wire, and then plunge it into the same, which has the property of drawing out the inferior metal from the alloy and of restoring the surface of the gold to its pure state; it is precisely as if a thin coating of fine gold were added to the trinket. Since the invention of electro-metallurgy, the colour is very often placed, as here sug-

gested, by an additional coating, but the old method is preferable.

Putting in the colour simply means bringing the surface of the article to the colour of fine gold, it does not signify giving the surface any particular colour; it is through the alloys alone that we get their varied tints, from which the jewellers of the eighteenth century obtained such charming results, and which to-day, again, are all the rage. The following, according to the "Dictionnaire des Arts et Manufactures," is the composition of these different alloys:—

"*Yellow gold* = fine gold.

"*Red gold* = 750 parts of fine gold + 250 of rose-copper.

"*Green gold* = 750 of fine gold + 250 of silver.

"*Dead leaf gold* = 700 of fine gold + 300 of silver.

"*Water-green gold* = 600 of fine gold + 400 of silver.

"*White gold.*—Here the colour is softened by adding silver in greater and greater quantities.

"*Blue gold* = 750 of fine gold + 250 of iron. This alloy is difficult of preparation; it is obtained by placing a thick wire of iron in the centre of the molten gold, and withdrawing it as soon as the alloy is made. The alloy being ready is poured out, and ought not to be porous; it is then heated in the forge and reduced to bars, or wires of different thicknesses."

Trinkets of all colours can be either left dead, or be burnished and polished. Burnishing and polishing in the case of those trinkets which have no stones is extremely easy. The article is at first *gratte-boëssé*, that is to say, submitted to the action of a metallic brush revolving very rapidly. A jet of water, slightly mixed with mucilage, flows from a little reservoir above and damps the surface of the trinket. The metallic brush is put in motion by a wheel worked by a pedal; as this wheel is large in proportion to the diameter of the brush, a very rapid speed is attained. This friction does not take off a single particle of the metal, but it smoothes the surface and prepares it to receive the burnishing.

Trinkets with stones set in, or, correctly speaking, diamond jewellery, are submitted, in addition to the processes already described, to a special operation, which is intended to fix the precious stones in the metal as solidly as possible. This operation is termed "setting;" it is quite an art in itself, and certain workmen have attained an unheard-of skill in this branch.

When a jewel or gem has to be mounted on silver they commence operations by preparing what they term the collet-joint (*charnière à chaton*). For this they take a slip of sheet-silver, which they sharpen at one end, and then bend over a little hollow anvil called the *cambroir*, or curver; when it is bent and

BORING HOLES WITH THE DRILL.

curved sufficiently they place a small mandril inside the arched slip, and striking the slip with a mallet, thus obtain a kind of tube, which is smoothed and made regular by being passed through a gauge-plate with holes of different sizes. The point which was prepared at the end of the slip of sheet-silver facilitates the introdution of the tube into the holes of the gauge-plate.

When finished this collet looks like a tube of thick shaving; with scissors the collet-joints are then cut, having at their centre an opening intended to receive the stone, which is enlarged at the expense of the tube-wall by cutting the metal out with a graver or chisel. The collets are then fastened together by soldering, the openings or holes being upwards, and the lower portion of the whole little mass being sheathed or coated with gold of a low standard—an alloy of gold and silver. This coating is meant to strengthen the setting, which, if it were all of silver, would bend and give too readily.

After this sheathing the piece is given to the setter, who fixes it in a tiny vice, or oftener in a pellet of cement inserted in a punch—of which he has every size and form handy for selection, according to the size of the jewel. With a little ball of paste, made of virgin wax and charcoal, he takes from his box the diamonds that are to be fixed, and presents them to the orifice of the collet, cutting away the metal until each stone can be pressed into its hole; then with another instrument he clamps down over the edges of the diamonds that are known as the *feuilletis* or *girdles*, enough metal to fix it as solidly as possible. He then trims the whole circumference of the collet to an edge, leaving here and there a counterfoil or shoulder, like the battlements of an old wall.

When the diamond is set in gold instead of in silver, the operation is very similar; but the setting is very often *open to the light*—that is to say, the collet is cut in such a manner as to leave the stock of the diamond visible.

Difficulties, that require much skill in their solution, are sometimes presented in the setting, not so much in jewellery properly so called, but in the jewellery of art. In the former, everything is settled for the arrangement of the stones; in the latter, everything should, on the contrary, be governed by form; thus those humming-birds and peacocks covered with precious stones were masterpieces of setting, for the workmen were obliged to fix in the metal only little projections or grains, to which the stones were attached, so as to preserve all the contours and lightness of the object.

Roses require a special form of setting; they are not as open as the brilliants, and ought to be lined with a little sheet of metal, the colours of which are left to the judgment of the workmen. The selection and disposition of this lining is of great moment in the cutting and sparkle of the rays.

The trinkets which are to be ornamented with diamonds or

coloured stones are, before being handed to the setters, fitted with collets, which are soldered on. This series of operations is the same as in jewellery.

The jewels and the trinkets of gold only, whether engraved or not, or enamelled or ornamented with cameos, precious stones of all colours, and fine stones, are now all ready to be burnished and polished.

The burnish is given with either a little steel instrument, or with the red stone known as hematite. For jewellery and trinkets they do not burnish much, but they produce the polish by other

THE POLISHING WORKSHOP.

means; thus after the *gratte-boëssage* (or scratch-brushing) they rub the object with stones of different kinds. The stone, soft slate of a fine grain, is cut into sticks, larger or smaller according to the object that has to be worked; or greenstone is used, which is much harder, and takes off the last roughnesses. The friction of the stone is followed by pouncing with pumice. For this operation they use little flat sticks of spindle-wood, broad or pointed at the end, with which they rub the object, after having moistened the part to be rubbed with pumice-stone bruised in oil to the consistency of a liquid paste; for the en-

POLISHING.

graved and carved parts, which would not admit the spindle-wood stick, however pointed it might be, they use a thread, thick or thin as necessary, moistened with this pumice-paste.

After this the piece is cleaned; then it is rubbed with Venetian tripoli (a preparation of whiting), always mixed with oil. For certain forms they use spindle-wood sticks, for others stuffed cloths, and for the carved and engraved parts the threads as before, which introduce the tripoli into the most inaccessible crannies. It is again cleaned so as to take off the least trace of the tripoli, and the last rubbing is made with powdered trip (subsulphate of iron) mixed with water, and applied at the ends of sticks, or on scraps of linen, oftener still with the fingers. The objects are then washed in common soap, in a solution of white soap, passed through warm water, and dried in very fine

wood sawdust, heated over a little gas-jet. As a finishing touch, they pass over the trinket a brush, having very long and very soft hairs, and containing at its extremity a very small quantity of red powder; these brushes are cleaned upon an iron rasp, which thus obtains a splendid polish. Nothing now is left but to place the trinket in its case, where it takes its true value.

The show-case of M. Rouvenat, at the *Exposition du Champ de Mars*, proves what a skilful jeweller can make of stones, perfectly chosen certainly, but of no extraordinary size. There are no sets of ornaments there worth many million francs, as in the English show-cases, but the articles exhibited are all made with an idea often novel, always happy, and peculiar to the maker. The branch of white lilac is one of the most curious examples of all his productions. The artist who composed it had, during the whole time he was at work, a real branch of white lilac before him, so as to observe all the details of form and outline. Each flower was separately copied from nature, and exactness was pushed as far as the reproduction of buds and half-opened

THE SCRATCH-BRUSH.

flowers, the four petals being each represented by a brilliant. They were especially desirous that the branches should be so flexible that at the least movement the whole bunch of flowers should tremble and scintillate in the lamp light. If they had employed little rods of gold sufficiently fine to produce this trembling, the rods would have broken or bent; if they had made the branches with spirals of very fine wire, they would not have afforded resistance enough, and the flowers would have hung down on all sides. M. Rouvenat had the happy idea of twisting round a mandril a little sheet of gold, two or three millimetres in thickness, and this formed a very elastic, and at the same time a very solid tube. The way it was twisted was so perfect, that after the polishing we were obliged to look close into it to trace, like a thin black line, the space that separated one spiral from the other; this plan had, in addition, the advantage of allowing them to fasten tubes, becoming gradually finer, one through the other, and so of imitating the gradation of the little branches and the flower-stems.

Each of the last is attached to the chief branches by a system of ferrules analogous to the fastening barrel on a bayonet. To

take them off they turn the knob or button under the flower at the extreme end of the branch to the left; they can then withdraw the tube-links one after the other, either for the purpose of cleaning them or to use them to deck a head-dress.

Finally, the better to imitate nature, they acknowledge they might have made the leaves of emeralds, which would have had a more accentuated effect; but M. Rouvenat wished before all to be a *jeweller*, and so he made his leaves of diamonds.

Beneath this lilac branch is a little mirror, of a chaste and elegant style, imitated from the ancient Greek. It is mounted in gold, inlaid with diamonds and lapis lazuli on one side, the other consisting of open-work gold over a bed of mother-of-pearls, relieved with incrustations of gold. The mirror consists of rock-crystal, but to harmonize perfectly with the style of frame, the mirror should have been made of burnished metal.

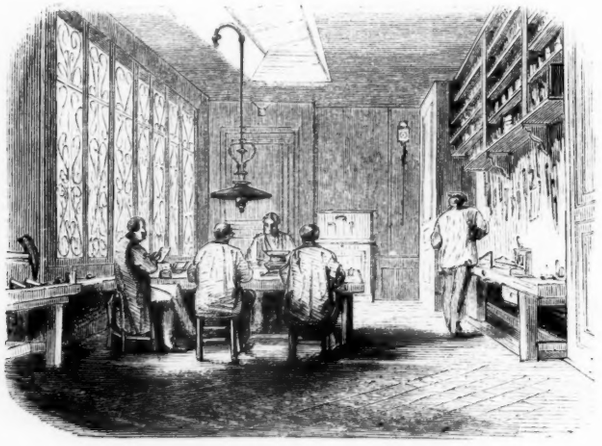
On one side we find the object that, according to our thinking, does most honour to M. Rouvenat of all his exhibits. This is a diadem of brilliants of charming design and remarkable execution. It is surmounted with large pears made of brilliants, and is most certainly a masterpiece of extreme delicacy and of pleasing appearance.

At the foot of the mirror, and almost entirely concealed from view by the other objects, is a very elegant knot, with brilliant drops. This knot is a part of a set composed of seven eglantine flowers, which, united or separate, form different combinations of the diadem, or brooches, more or less rich, according to the number of flowers gathered together.

With M. Rouvenat the old necklets composed of links have been replaced by necklaces imitated from Greek jewels with gold drops. A line of little brilliants set in a solid chain forms the top of the necklace, to which are suspended, by little chains of unequal lengths and covered with roses, brilliants varying in size according to position. This arrangement, by exhibiting the stones separately, shows their full value. They are also in this way able to throw out their dazzling rays in all directions; the appearance of their size is to a great extent governed by the careful gradations of their position.

In this way also they designed an ornament of the style of Henri II., composed of a network of rings (*maillons*) adorned with roses surrounding the rows of brilliants which form the thread or cord on which they are strung, each ring being connected with the next by a hinge-joint. This ornament may be used either as a band or as a bracelet. Another set in the same style is composed of a necklace of gold plates, and brooch and a bracelet, and is nobly and elegantly designed; another necklace with large links and drops is less ornamented in detail, but the stones are better detached, and have much more effect.

The gold jewellery is rather less rich, although there are some



MAKING CASES.

sets showing a happy combination of ideas; these have both precious stones and a cross composed of six large brilliants, united by roses. The objects of art are numerous, and much to be admired; among them we again notice the peacock, the butterflies, the dragon-fly, and the humming-birds which we saw previously in the workshops in the Rue Hauteville. One of these last, covered with diamonds, rubies, emeralds, and sapphires, was purchased by the late Emperor.

The cameos—again coming into fashion—are not ancient stones, but of thoroughly modern cutting; for several years they have been executed in France with a perfection worthy of the antique. They are in general mounted in brooches, surrounded with brilliants or with roses, and the style of their mounts accords with the severity of their class. The principal figures represented are the Bathing Girl of Falconnet, Cupid and Psyche, Erebus, a fine St. George, a triumph of Cæsar, &c.

In order that every class of these precious manufactures might be represented, they have placed in the show-case a beautiful cup of white jade, brought from China—coming, indeed, from the sacking of the Summer Palace; the mounting, executed in France, is of silver gilt, with ornaments of lapis lazuli, bouquet holders, both enamelled and plain, accompanying the cup. A crowd of little articles in gold and stones, or in gold only, adorn the vacant places, and show the vast variety and scope of modern jewellery. Almost all the epochs are there represented—Louis XVI., Louis XIV., the Renaissance, Greek art and Roman. The appearance of the whole is very elegant.

The recognition which M. Rouvenat has so worthily obtained in several exhibitions is due not only to the taste and the execution of the objects exhibited by him, but more especially to the capital manner in which he directs his workshops, filled with select workmen, whose true value we have been able, in the course of our long investigations, to appreciate, not only as artists, but still more as men. Their earnings are in general very high; those working at the costlier and more fanciful articles are paid by the day, and make from eight to ten francs. The others, occupied in the manufacture of common objects, are paid by the piece, and if they work rapidly are able to net from seven to ten francs a day.

We must also add, that we have rarely noticed a better feeling or a truer union of interests than is to be found here between the workmen, the superintendents, and the chiefs of the establishment.

A superannuation fund assures to every one who has worked for more than ten years in the house a sum increasing with the annual interest from the time of the tenth year. A sick fund, organized by the workmen, and in which M. Rouvenat, his brother, and M. Lourdel, his son-in-law, take part as honorary members, gives all the invalids after five successive days' inability to labour a daily allowance of two francs. Finally, several annual prizes of fifty francs each are bestowed upon those workmen who have been most distinguished for their punctuality in the shops, for their skill, and for the perfection of their workmanship.

THE FUGGERS OF AUGSBURG.

AMONG the towns of Upper Germany, which in the middle ages formed the connecting links of the two portions of Europe separated by the Alps, and first introduced the commercial products of the shores of the Mediterranean and India into northern lands, Augsburg and Nuremberg occupy the most prominent positions. And the former maintained this pre-eminence when afterwards it became expedient to direct the transatlantic trade on the newly-discovered ocean-routes into Germany and the eastern parts of our continent. As Nuremberg was famous for its fine gold and silver work, carvings, castings, &c., so Augsburg, whose fairs were already numerously attended in the eleventh century, was early celebrated for its linen products, to which were afterwards added silk and cotton stuffs, subsequently wood carvings, and finally for its monetary wealth. The merchants of both cities had, by way of Venice, Genoa, and Marseilles, become as much at home in the markets of the East as they afterwards were well known in the New World, with which they formed connections by way of Antwerp and Lisbon. Names like those of the Behaims and Welser are inseparably intertwined with the history of discovery and conquest in the most distant parts of the globe. But in the sixteenth century Augsburg shot ahead of Nuremberg, and excelled its rival both as regarded wealth and means, and extension of its connections, and as to the importance of single enterprises and associated commercial ventures.

Augsburg, formerly a free imperial city, situated at the confluence of the Lech and Wertach, is one of the most ancient towns of Germany. Its origin is supposed to have been the colony founded by the Emperor Augustus after his conquest of the Vindelici. It speedily grew in size and importance, and became the central point of the warlike enterprises of the Romans in Germany. In the fifth century it was ravaged by the Huns, and, after having passed under the dominion of several princes, it became a free imperial city under Rodolphus of Habsburg. In the fourteenth century it was a flourishing city, and, under Maximilian I., had eighty thousand inhabitants. It enjoyed a great advantage by being so near the Alps, and yet not too far removed from the commerce of North Germany, and thus was by nature fitted to be the *entrepôt* between the south and the north and east of Europe.

No wonder that banking and mercantile establishments arose in this city, families which in regard to wealth and extensive transactions, high position and distinguished connections, culture and the patronage of art and science, were not inferior to the princely merchants of Venice and Florence; though, in consequence of the totally different circumstances of the German empire, they could not, like the Medici, raise brilliant dukedoms on their ledgers; but, even as princes of the empire, remained merchants and citizens of their native cities.

Certes, the period of the cultivation of the arts among the citizens of the towns of Upper Germany did not pass by without leaving its traces on public life. It is seen in the erection of fountains and other monumental works. The fronts of many ancient houses are still decorated with paintings of more or less artistic value, giving to those towns a cheerful, comfortable appearance, and forming at the same time pleasing street ornamentation not to be found in Lower Germany. But the paintings on the mansion of the Fuggers at Augsburg do not date from that early period, but are modern works. The frescoes in question represent the granting of the first Book of Rights by the Emperor Rudolph of Habsburg in 1276. The emperor is enthroned in his imperial robes; to his left kneels a page with the Town-book, while the heads of the city are respectfully awaiting the imperial assent. The frieze, sides, and lower portions of the painting consist of ingenious allegories having reference to the history and rise of the Fugger family. The patron of art, to whom the Maximilian Street owes this beautiful painting, is Prince Leopold von Fugger-Babenhausen, a descendant of that famous patrician Augsburg family.

John Fugger, the oldest known ancestor of this house, was a master weaver at Grabens, a village near Augsburg. His eldest son John continued the father's business, and, to improve it, settled at Augsburg. Here, by marrying a citizen's daughter, he obtained in 1370 the freedom of the city. Gradually his business increased, and Fugger engaged in extensive dealings in cotton. After the death of his first wife he married the daughter of a councilman; and as one of the twelve members of the guild of weavers who had seats in the town council, as well as a sheriff (*frei-schöppe*) of the Westphalian Vehme, enjoyed a distinguished position. At his death he left the then considerable fortune of 3,000 gold florins. His eldest son Andreas carried on the business with such great and rapid success that he soon justly was known by the cognomen of the "rich" Fugger. He married a lady of the patrician family Stammler vom Ast, and became the founder of the patrician line of the Fugger vom Reh (of the deer), so called from the coat of arms, a golden deer in a blue field, which his sons received in 1452 from the Emperor Frederick III. But this line became extinct in 1583. His second son Jakob, also a distinguished citizen of Augsburg, likewise carried on a large commercial business, and died as the founder of the still existing line of the Fugger von den Lilien (of the Lilies). Of his many children, the business was carried on with skill and ever-growing success by several sons at Augsburg, Nuremberg and Venice, where they had counting-houses, whilst two other sons devoted themselves to science and the church. But when in a short time three of the brothers died in rapid succession, and only Ulrich, George, and Jakob were left to represent the family, the latter was urgently entreated to leave the clerical institution to which he had retired, and to take his share in the affairs of the house. Tradition says that it cost him a violent struggle to decide as to the course he should pursue, but that a dream at last determined him to leave his retreat and engage in secular avocations. More probably this was simply a pretext to keep down the odium which in that age attached to any one leaving the church after having once entered it, for the skill and aptitude he showed for commercial life, when once he had undertaken the management of the Venice branch, prove that he must have studied the principles of "profit and loss" even in his holy retirement. Among other things he directed his attention to an article of commerce which soon acquired considerable importance—that is cotton goods, and especially fustian, which were made chiefly at Augsburg, and thence forwarded to Venice for export. He bartered these goods for spices, silk, and other East Indian produce, which by way of Augsburg and Nuremberg not only were introduced into Southern but the farthest limits of Northern Germany, Italy, Hungary, Poland, and the Netherlands.

Whilst Jakob Fugger (II., also called the younger) at Venice in so brilliant a manner promoted the interest of the firm, the two elder brothers George and Ulrich did their part in Germany. Ulrich especially increased the influence and wealth of the house by extending its operations to all kinds of merchandize. Thus, he dealt in works of art, and introduced Albrecht Dürer's works into Italy. He moreover sought to raise the position of the family by marriages with rich and noble houses. And it was chiefly to Ulrich that the Fuggers were indebted for their connection with the princes of Austria.

For when the Emperor Frederick III. undertook his progress to the Rhine to bestow the royal crown on Charles the Bold, and in return to win for his son Maximilian the daughter and heiress of the rich Burgundian, Ulrich Fugger furnished the emperor and his train with cloth and silk stuffs, and probably also with money and jewels. This ready assistance on the part of the Fuggers to the chief prince of Christendom was not only followed by the grant of a new coat of arms, but a natural increase of the estimation and influence of the house, whose name was known far and wide, and enjoyed the highest confidence in the commercial world. And whilst the firm employed thirty looms at Augsburg, and its fleets were on every sea, and trading caravans under the escort of armed men in the pay of the merchants travelled across the Brenner into Italy, hundreds of miners were at work for the rich Fuggers in the mines of Tyrol and Hungary. For Jakob Fugger, who had left Venice and come to live at Augsburg, where he married the rich and beautiful Sibylla Arzet, had taken in hand the Hungarian mines, hitherto only partially worked, and thus secured the entire copper trade of the Magyar free towns, as well as the mines of the imperial free cities, Old and New Sohl. Thence, as well as from the gold and lead mines of Carinthia and Tyrol, which he had formed, he derived great wealth; so that he could advance the Archduke of Austria, the ruler of Tyrol, 150,000 gold florins, and build for himself in the most beautiful district of that mountain-land the magnificent castle of Fuggerau. The noble metals won from the mines were, in the mints of the Fuggers at Innspruck and Kremnitz, coined into imperial money. Moreover, the former hermit, who was now considered the richest merchant in Europe, obtained the greatest influence on all the markets of Europe by his widely extended exchange business, which opened up to him from year to year greater advantages. But independently of his extraordinary commercial activity, Jakob Fugger also distinguished himself as a circumspect statesman, and acquired great political influence as imperial councillor in the service of Maximilian I.

Though of too great an age to be pleased with the reforming tendencies of his period, Jakob Fugger yet was the intimate friend of many enlightened men, such as Peutinger, Pirkheimer,

Stabius, and others. Thus in every respect he proved himself a man of rare intellectual gifts, to which those of his heart were not inferior. Though fortune always remained true to him, he never forgot the duties of a good citizen; he declined or evaded no opportunity of benefiting his townsmen, protected arts and sciences, and exercised a most liberal benevolence towards the poor and afflicted.

Like Jakob, his two elder brothers employed their wealth in the noblest manner, and the three Fuggers, by the erection of important buildings, testified as well to their taste for art as to their large-hearted charity. In 1512 they erected the beautiful choir in the church of St. Ann, with a tomb for their family, and seven years after they founded the celebrated "Fuggerei." For this purpose they purchased of several owners a large piece of land in the suburb Jakobi, and erected thereon no less than 106 small, wholesome dwellings, in which they lodged poor citizens and inhabitants at the nominal rent of two florins a year, and endowed the foundation, so that it should continue after their death. It is in existence at the present day. The brothers Fugger also built the "Holzhaus," for thirty-two strangers, and especially such as suffered from the then widely spread malignant small-pox.

The Emperor Maximilian I. knew how to appreciate such citizens. He drew them into his personal and intimate service. In all important commercial and financial questions the emperor consulted the experienced merchants. The Fuggers always were the advocates of free trade; urged even then the adoption of uniform weights, measures, and money, the construction of good roads, and the removal of burdensome tolls and customs duties. The emperor granted the brothers special privileges, and made them nobles of the empire. In 1504 he mortgaged to them the county of Kirchberg, together with the manor of Weissenhorn, for the sum of 70,000 gold florins. The merchants of Augsburg, and especially the rich Fuggers, were frequently obliged to make large advances to their protector, who was constantly engaged in war of some kind, even when it was not very convenient to make such advances, or they did not appear advantageous to them; wherefore in 1508 they obtained the emperor's promise and assurance that thenceforth no such forced loan should be exacted from them.

In the following year Jakob Fugger advanced the emperor on bills the sum of 170,000 ducats, which Pope Julius II. and the kings of France and Spain were bound by treaty to supply for the war against Venice.

The closing years of Jakob Fugger's life were overshadowed by several trials. His wife had borne him no child; his nephew, the richly-gifted Ulrich, had taken part in a rebellion of peasants and met with his death at the age of thirty-five; his brother Hieronymus was inferior in mental endowments. The discontented Tyrolese caused Jakob much trouble. They threatened the castle Fuggerau, near Innspruck, and in his Swabian domains the country people, in open rebellion, indulged in murder, incendiarism, and devastation. The old gentleman, now in his sixty-sixth year, could not well bear these crosses, and so departed this life on the 30th December, 1525.

In the first decades of the sixteenth century several lines of the Fuggers became extinct one after the other, so that all the possessions of the house fell to the descendant of one George Fugger (born May, 1453, died May, 1506). Of his three sons, Marcus died in 1511 as priest, whilst Raimund and Anton became the founders of the two yet existing lines of the house. Anton especially greatly increased the wealth of the family by working the Spanish silver mines, and founding a branch establishment at Antwerp, to promote their East India trade. His and his brother's ships traversed every sea.

This Anton was particularly favoured by the Emperor Charles V., and when the latter attended the Imperial Diet at Augsburg, he lodged in the splendid Fugger mansion in the Weinmarkt. The Fuggers had advanced him and his brother large sums, and rendered him other important services. They were, moreover, highly esteemed by the emperor because they remained attached to the Roman Catholic Church, whilst many other rich families of Augsburg, and especially the Welsers, joined the Reformers. In order to maintain the influence of the old creed at Augsburg, the Fuggers purchased of Pope Leo X. the advowson of the collegiate church of St. Moritz, and actively opposed the spread of the Reformation in Augsburg and Germany in general. They lent Catholic princes of the Church money, looking for their repayment to the receipts for the sale of indulgences, and supported, among others, Dr. Eck in his struggle with Luther and the inhabitants of Wittenberg. In recognition of these services, the emperor, in November, 1530, raised the brothers Raimund and Anton, and their cousin Hieronymus, to the dignity of counts and bannerets, granted them seats in the Imperial Diet, and thus aggregated them to the representatives of the empire. Therewith they also received full jurisdiction on all their estates, the right to seal with red wax, and to assume the titles of their estates. Wherever they settled, their privileges were to be paramount to those of any other family, nor were they to be subject to any jurisdiction except that of the emperor himself. They were to be at liberty to claim these privileges at once or at any future time, nor was the fact of their waiving them at any time to cause them to lapse. As protectors of these rights the Emperor appointed, besides his brother Ferdinand, a number of princes of the empire. Besides these extraordinary privileges, they obtained moreover in 1535, after having made the emperor a further loan for his expedition against Algiers, the right of coining gold and silver money.

In the succeeding decades of the 16th century the commercial activity and enterprise of the Fuggers were ever on the increase. Their interests were represented by agents in all the four quarters of the compass. They transported the products of home industry and of their mines southward across the Alps by means of goods caravans, always attended with danger and sometimes with loss of lives and property, and towards the north as far as the German Ocean and Baltic Sea. Their ships laden with rich cargoes went up and down the Rhine, and by way of Antwerp to Lisbon. They were careful to maintain friendly relations with their Portuguese and Spanish correspondents, as they were largely interested in trans-oceanic speculations. Fugger's ships were also met with in the Northern and Mediterranean Seas, importing the spices and gems of the East, the drugs and dyes of India, as well as the treasures of the New World, and exporting the products of domestic industry and the ores found in the native soil. At the same time the Fuggers carried on financial and exchange operations on a most extensive scale, and their wealth was so great that the loss of a fleet of twenty ships in the German Ocean could not affect it.

Thus one single mediæval trading firm embraced within its sphere of operations nearly every branch of commercial enterprise, and this to an extent of which scarcely an instance may be found in more recent times. Such comprehensiveness, however, is neither possible nor needed now. Commerce and industry have assumed such gigantic proportions and multifarious phases that their supervision by one head is become an impossibility, and the profits now derivable from the manufacture of or dealing in one single article of commerce are so great that attention to many articles is not absolutely necessary for the acquisition of considerable wealth. Division of labour in intellectual, scientific, commercial, and industrial pursuits has now become the universal rule, founded on necessity.

It was a fact of great importance to the Fuggers when King Ferdinand, with the emperor's consent, granted them the earldom of Kirchberg and the manor of Weissenhorn, which hitherto they had held on mortgage only, for heritable possessions, for thereby their rank of counts was placed on a permanent basis. They increased their territorial property by purchasing in 1533 the village and castle of Oberndorf on the Lech for 21,000 gold florins, the castellany of Donauwörth for 6,600 florins, and the village of Glött for 16,400 florins. Anton Fugger, moreover, purchased the castle of Babenhausen with the villages dependent on it, and afterwards the manor of Mickhausen. But in spite of their great wealth, the Fuggers abstained from claiming all the privileges they had been granted in their native city, as in that case they would have been obliged to renounce their profitable commerce, which, on the contrary, they were ever anxious to increase. Wherefore they endeavoured to remain on good terms with the authorities of Augsburg, representing to them among other facts that as their property was dispersed in many parts of the world, and subject to various fluctuations, it was impossible for them, like other citizens, annually to declare the actual state of their effects, and to be taxed accordingly; they therefore proposed to pay an annual composition. The town council admitted the justice of the plea, and it was arranged that the three brothers should during their lives each pay a composition of 800 gold florins a year.

The Fuggers and some other merchants of Augsburg were the first Germans who fitted out ships at their own expense to take a share in the commercial enterprises in the Indian seas. The merchants who carried on the new-born commerce extending over the earth at that time received from their foreign factories, as well as through their captains, the latest news, generally earlier than the German kings and princes. Thus Raimund Fugger was enabled to send such news, which he received from the East and West Indies by way of Lisbon, to his friend the Count Palatine Otto Heinrich; he watched with the greatest attention the departure and arrival of the Portuguese mercantile fleets, noted the nature and value of their cargoes, and the progress and issue of the conquest of Peru by Pizarro, as well as other events in those distant parts of the world.

Hieronymus, the last of the Ulrich Fugger line, died in November, 1538, having entailed his considerable fortune in

favour of the sons of his uncle George. In his will he also ordered that after his death 2,000 gold florins should be distributed among the poor, and left a large sum for the erection of a hospital for poor subjects of the Fugger family, and the annual distribution of alms.

Augsburg, chiefly influenced by Hans Welser, had attached itself to the new doctrine of Luther. Now, when in 1546 the religious war began, and Charles V. made ready with force of arms to lead the reformed states and towns back into the bosom of the Roman Catholic Church, Augsburg also was obliged with the other members of the Evangelical League to prepare for resistance to the Emperor. Partly to attach Augsburg more strongly to itself, and partly from necessity, the League endeavoured to obtain a heavy loan from that city. Its envoys were instructed to complain to the town council that Augsburg families, especially the Welsers, Fuggers, and Baumgartens had lent large sums to the emperor and his allies; and as they had heard that the King of England was about shortly to repay those firms considerable advances made to him, they requested the council to compel those citizens to lend the League a large amount on the security of confiscated clerical property. The town council replied that they knew nothing of the English money, nor could they call on the Fuggers and Welsers to make such advances, as the greater portion of their property was invested in Spain and the Netherlands; the Baumgartens had long ago ceased residing at Augsburg. But the council promised to raise a loan, and did in fact, besides paying the considerable contribution to the League, procure the sum of 150,000 gold florins. Soon, however, Charles V. advanced with a large host. The citizens of Augsburg were seized with a panic, and determined on suing for peace and the emperor's grace. No one seemed fitter to undertake this somewhat difficult mission than Anton Fugger, who was high in the emperor's favour, and also enjoyed the confidence of his fellow-citizens, though since the introduction of the reformed creed he had chiefly resided on his estates. He readily undertook the task, but the emperor would hear of nothing but surrender at discretion, to which the citizens of Augsburg had to submit, renouncing all treaties and alliances against the emperor, dismissing its mercenaries, receiving an imperial garrison, recalling all those inhabitants who had been banished on account of their religion, and paying an indemnity of 150,000 gold florins, and surrendering twelve pieces of artillery. The town had, moreover, to pay heavy compensation to neighbouring princes and proprietors on account of damage done by the state of war into which the country had been thrown; so that the preference for Luther's doctrine cost the town some 2,000,000 gold florins. The emperor further deposed the council selected from the members of guilds, and decreed that in future it should consist entirely of members chosen from the aristocracy. Four members of the Fugger family sat in the first council thus constituted.

The political and social position of the Fuggers was thus greatly benefited. They were at the same time careful to guard and increase their wealth. With this view Anton Fugger in 1548 agreed with the sons of his brother that the property coming to them jointly from Jakob and Hieronymus Fugger should never descend to any one but the head of the house. They also endeavoured to improve their position by marriages with distinguished families. In 1553 Anton Fugger celebrated the marriage of his daughter Catherine with Count Jakob de Montfort, and in 1557 Marcus Fugger married the Countess Sibylla of Eberstein, and in the following year the daughter of Hans Jakob, Eleanor Secunda, was united to Lord Siegmund von Lamberg.

In 1560 Anton Fugger grew dangerously ill. When he felt his end approaching, he ordered that every poor or sick person in the hospitals and infirmaries of Augsburg should receive four florins, and that 1000 dollars were to be distributed among poor citizens and 1000 dollars among beggars. He died in September, 1560, deeply lamented by all parties, and leaving three sons, Marcus, John, and Jakob, who became the founders of the three lines of Nordendorf, Kirchheim, and Wellenburg.

Anton was one of the most distinguished members of the Fugger family, a good citizen, and far-seeing man of business. His household sometimes cost enormous sums, when his position as counsellor and host of the Emperor of Germany, or friend of some of the first princes of the empire, laid onerous duties upon him. Yet he left six millions of gold crowns in cash, jewels, gems, and valuables, and estates in all parts of Europe and both the Indies; and it is supposed the Emperor Charles alluded to him when, after having inspected the royal treasury at Paris, he said: "At Augsburg there is a linen-weaver who can buy all this with his own gold." Under these circumstances the following anecdote, often repeated, loses its improbability. When Charles V., on his expedition to Tunis, stayed at the house of Anton, the latter is said to have kindled a fire of cinnamon-wood in the chimney, and in honour of the gracious visit to have burnt in it the emperor's acknowledgment for the large sum Anton had advanced to him for the purpose of the expedition. Indeed, the houses of the Fuggers at Augsburg belonged to the most sumptuous and elegant in the whole German empire, containing large collections of books and works of art.

This splendid position, which often brings with it a wasteful ostentation, and has become the rock on which the happiness of many a family has been wrecked, was full of danger for Raimund and his sons. Ulrich Fugger, who had remained single and joined the Protestants, involved himself, by the excessive liberality with which he treated learned men and artists and the sums he spent on the collection of rare MSS. books and works of art, in debt to the amount of more than 200,000 florins. Though his fortune was large enough to pay all those debts, yet his brothers John, Jakob, and Marcus, succeeded with the town council so far as to get him confined to his own house as a spendthrift, whilst they themselves were appointed managers of his property. He therefore applied to the Imperial Chamber, and at first obtained a decree in his favour, but eventually his brothers were able to get the Augsburg sentence confirmed. Whilst Ulrich was under arrest they sold his collections piece-meal. After paying his debts, he had some 70,000 florins left; yet his brothers only allowed him 1,300 florins a year, with which he went to Heidelberg and resided with the Elector Palatine Frederick, where he remained, even after he had been reinstated in the possession of his property, until his death, which occurred in 1584, leaving his library to his princely friend.

In 1568 other disputes arose in the family; the sons of Raimund began a long, difficult and costly law-suit against the sons of Anton. Whilst each line managed the estates it possessed of its own in an independent manner, the commercial business had always been looked upon as a possession in common. This circumstance led to every kind of confusion when the trading property of either line had become very unequal. The strife lasted for years. In vain the most distinguished men of Augsburg and the neighbouring nobility sought to effect a reconciliation, when in 1571 new dissensions arose; the law-suits were continued with renewed fury; but finally it was decided that Anton Fugger had left, as we mentioned above, to his sons a trading capital of more than 6,000,000 florins, while Raimund had left no more than 300,000 florins.

The sons of Anton increased the splendour of their house by marriages with some of the most aristocratic families of Southern Germany, with counts, lords, and barons. On the marriage of Anne Maria Fugger with the Lord of Rechberg, a cavalcade of 548 guests and servitors entered the town, and the festivities were kept up for four days. The line of Raimund also greatly enhanced its position and wealth, and Christopher Fugger, the son of Raimund, who died unmarried in 1579, was pointed out as the richest among the Fuggers. With his immense fortune he created an entailed estate in favour of his brothers and their children, on condition that they should, according to their own discretion, expend 30,000 florins on the foundation of a charitable institution.

During the wars between Spain and the Netherlands many a great commercial firm of Augsburg was ruined, chiefly because there was no German navy to protect the Augsburg commercial fleets with their rich cargoes on their way from Lisbon to Antwerp. But the losses the Fuggers sustained at sea were made up by profitable speculations on land. It is in fact remarkable how cautiously the older families, such as the Welsers and Fuggers, withdrew portions of their capital from commerce, and consolidated their wealth by the purchase of landed property; and how they energetically crushed every disposition on the part of any member of the family to waste the wealth once acquired. Thus, in 1581, another Fugger, Raimund, was at the instance of his brothers declared a spendthrift by the magistrates; but he induced the Archduke Ferdinand of Austria, whose cup-bearer he was, to take into his own hands the management of the estates belonging to the Fugger family in common, viz., the county of Kirchberg and the lordships of Weissenhorn, Marstetten, Pfaffenhofen and Wubenstetten, and to retain the revenues until the family had come to an arrangement with Raimund and restored him his property. Towards the end of the 16th century the Fuggers entered into matrimonial relations with the princely houses of Hohenzollern, Schwarzenberg, and Oettingen. In February, 1590, Anton Fugger, the son of Marcus Fugger, fetched home his bride with more than 700 horses, and numerous coaches and six; and splendid tournaments were held in the Weinmarkt on two consecutive days. On the third day, Christopher Fugger, in honour of the bridal pair, had a hill made of wood and coarse linen, intended to represent Mount Parnassus, and occupied by musicians, erected on the market place, and a small castle by its side, from whose tiny battlements salutes

were fired, after which the whole hill and castle was consumed in a joyous bonfire.

But the above-named Fugger, as early as 1594, in consequence of his excessive liberality and love of pomp, became overwhelmed with debts; hence further accusations and disputes before the magistrates. The hardly-pressed debtor secretly left the city, but was arrested and sent back to Augsburg, where he was kept a prisoner in a room of the Town Hall. The two burgomasters took an inventory of his property, and Anton had to make over to his creditors absolutely, and in full payments of all his debts, his estates of Hainhofen, Ottmanshausen, Eichstetten, and some others.

The son of the elder Anton, Marcus, one of Augsburg's most distinguished citizens, died in June, 1597. He was famous for his learning, and was a great patron of learned men. Another Fugger, Siegmund Frederick, the son of Jakob Fugger, about that time became Bishop of Ratisbon. Philip Edouard Fugger also, the son of George, was distinguished for his learning; but alas, was so much under the influence of the priests that he persuaded his brothers and cousins to devote the 30,000 florins left by Christopher, as well as 12,000 florins obtained by the sale of the latter's house, to the erection of a Jesuits' college at Augsburg. He had, however, great taste for art, promoted the erection of monumental buildings, especially of the new Town Hall, built in the renaissance style, and whose "Golden Hall" forms one of the most attractive sights of that city. He greatly enriched the collection of antiquities begun by the eldest Raimund, and formed a library of 15,000 volumes, which however, in 1653, was sold to the Emperor Ferdinand III. Another distinguished member of the family was Jakob, Bishop of Constance. He was zealously attached to his religion without being blind to the faults of the Church, founded a monastery of capuchin monks and promoted the erection of the Jesuits' college—but a sorry application of wealth created by industry and enlightened liberality.

Other members of the Fugger family in the 17th century rendered themselves famous in the emperor's military and civil service, and gained the most distinguished posts in either branch of the service. Otto Henry Fugger in 1618 led a regiment, raised by himself, to assist the Duke of Alba against the Dutch Protestants, fought in Spain, France, Germany, and Bohemia, and in conjunction with Tilly made war in Franconia and Suabia. As imperial field-marshal he took part in the battle of Nördlingen, and in 1635 took the city of Augsburg, deposing the Protestant authorities and setting up Roman Catholics in their stead. He died in 1644, having greatly raised the honours and enlarged the possessions of his family by the acquisition of additional lordships.

In the 18th century also the family belonged to the foremost of the empire. Whilst some of its members occupied the highest offices, those settled in their native town continued the mercantile operations. It was only towards the end of that century that they more and more withdrew from business, and when Augsburg, and in fact all Germany, began to suffer under a general depression and decay, they abandoned it altogether, devoting themselves to the management of their numerous estates content with the advantages their nobility afforded them with regard to the military and political service of the country. And fortune did not desert them then. Count Anselm Maria Fugger, of the Wellenburg line (born in 1766, died in 1821), on account of his merits was raised by the German Emperor Francis II., together with his male descendants, to the rank of a prince of the empire.

At the present day the former principality of Babenhausen, comprising the lordships of Babenhausen, Boos and Kottersausen, seven square miles, with 11,000 inhabitants, is under the sovereignty of the Bavarian Crown, and the grandson of the first prince, Prince Leopold Fugger-Babenhausen, born in 1827, as Bavarian Lord High Chancellor, is invested with the dignity of hereditary imperial councillor. He is a great patron of art, and the decorations of the family mansion at Augsburg, spoken of at the beginning of this biographical sketch, were executed at his instance by one of Germany's best historical painters, Hermann Wagner. The antique building has a façade with twenty-six windows, whose irregular position offered great difficulties to the artist, which, however, he surmounted in the ablest manner.

Though Augsburg at present is only a second-rate town, yet its commerce and industry are of considerable importance. It contains cotton and worsted spinning mills, calico and wool dyeing establishments; wire, engine, silk, tobacco, paper and pianoforte manufactories; gas and chemical works. How much of its prosperity the city owes to the family whose history we have here traced may be left to the consideration of the thoughtful reader. The rise of the Fuggers, however, will always remain an interesting and encouraging chapter in the "romance of commerce."

NOTES FROM THE NORTH OF EUROPE.

The Cultivation of Lobsters.[1]

THE lobster is, as every one knows, a very important article of export from Norway, and a large portion of our coasting population finds constant occupation for some months every year in this branch of fishing, which brings them in very appreciable earnings. We hear, however, the same complaints here as elsewhere, that this shellfish is getting continually scarcer and inferior.

And this cannot be wondered at, for if one takes a ride in a boat along the coast on a day in July, and sees all the lobster-traps out, the matter is easily explained. A creature so much sought after must possess a wonderful power of reproduction to avoid being extirpated.

Certainly a large female lobster can, it seems, propagate its kind on a considerable scale; but it is the same with the lobster fry as with the oyster, only a very few can be fortunate enough to escape with their life from their various persecutors, until they grow large enough to contribute to the maintenance of the race.

As far as we know, no attempts have hitherto been made in this country at lobster-breeding.

It may therefore be interesting to hear something about an experiment which has lately succeeded to such a degree that, in our opinion, more extended measures should be taken for the promotion of the matter.

Last year a Mr. A. Hansen, of Akrehavn, informed Mr. Lorange, an engineer, that he had seen a large quantity of young lobsters in the ordinary lobster boxes.

This gave Lorange the idea of hatching lobsters in such boxes and afterwards protecting the young till they were large enough to take care of themselves. A few experiments on a small scale were made last year at Akrehavn and Kopervik, but as it was already late in September, and the attempt was made in small boxes with lids, it could not be expected to succeed very well.

This year, however, they began in good time, Mr. A. Hansen and his son, Mr. H. J. Hansen, taking a large box furnished, instead of a lid, with a rim round the edges, so that the lobster could not get out, whilst it was accessible to the sun and air.

On Saturday, the 5th July, they put into the box three full-grown female lobsters, and by the following Tuesday they saw a large quantity of fry; on the following days the number so increased that by the end of the week they saw thousands.

The fry floats at first on the surface of the water undeveloped, but grows rapidly, and after fourteen days is about half an inch long.

It still, however, keeps at the surface of the water, where it swims about actively.

This circumstance renders it difficult for the lobster to increase and multiply.

Mr. A. Hansen speaks on the subject as follows:—"I used before to wonder that there are so few lobsters; now I am more surprised that there are any at all. Let us only just think what happens to the lobster fry hatched in the open water.

"If the wind is inshore the fry is driven up on the beach, where it dries up and dies, or becomes the prey of land-birds; if the wind and current are seawards, the fry is carried out into such deep and cold waters, that it is difficult, not to say impossible, for it to survive.

"If it is fortunate enough to escape these dangers, the young lobster, as long as it is small and weak and swims on the surface of the water, is very welcome food for herrings and roach, as well as terns and other waterfowl; the young lobster seems everywhere doomed to destruction as soon as it has seen the light of day.

"But if it could be protected till the young get large enough to seek at the bottom of the sea their natural hiding-places among the seaweed and stones, there is no doubt that the produce of our lobster fisheries could be enormously extended."

Mr. Hansen, of Akrehavn, Mr. Lorange, engineer, and Mr. Olsen, school-inspector at Kopervik, have now joined to continue operations on the bases of the experience already obtained.

They think now of enclosing a park, where the young lobsters can be gradually put out as they are hatched in the box, and protected at least till they have grown large enough to find their

[1] From the "Karmsunds Posten."

way to the bottom of the sea. They assume that towards the autumn they will be large enough to be able to protect themselves from their worst enemies, on which account they will not be let out of the park before. For an object of such general utility they ought in one way or another to be able to raise the funds required for the first experiments.

Should it appear that the matter has no practical difficulties, lobster-hatching ought to be taken up by a commune or by the state. It cannot, of course, be expected that any private individual should take up with lobster-breeding; for the lobster does not, like the salmon, keep to a certain place protected by the laws of private property, but roves along the whole coast, and is caught in the public fishing-ground—the sea. It would not be at all encouraging for a private individual to employ time and trouble in an undertaking but a very small part of the returns of which falls to his share.

Of the young lobsters hatched a few specimens are taken every fortnight and put in spirit, so as to show how fast they grow. Of these specimens in spirit some are sent to Professor Rasch, of Christiania, who will be asked kindly to assist in future experiments.

Fiskeby Paper Mill.[1]

The manufacture of pasteboard in long strips has extended very much in our country during the last few years, and the article produced has also won favour abroad and been largely exported.

A short time ago a limited company was formed at Norrköping for the manufacture of yellow pasteboard for lining purposes, &c., for which purpose a large mill has been put up at Fiskeby, about 1½ miles (English) from Norrköping, by the side of the Motala River; it has only been at work a few months, but has proved such a success that it can barely keep pace with the orders which come in. The manager is Mr. John Blomberg.

A small station will shortly be completed at Fiskeby, which is on the eastern main line, but at present one has to drive there.

The first thing the visitor comes across is a number of enormous ricks of straw, which form regular streets, so that the place might very well be called Halmstad (Strawtown).

This straw, which is brought there by thousands of loads, at a heavy expense, and often from a considerable distance, is one of the most important materials in this manufacture.

We soon leave the ricks of straw, and find ourselves in front of the house where the talented overseer of the mill resides, and a few yards further on we come to an open court or square, surrounded on three sides by houses.

We first notice the long mill, three stories high; near this we observe the boiler and bucking-house, built together, the former having a chimney 97 ft. high; and down by the river there is a smaller building, with blacksmiths' and carpenters' shops on the ground-floor; the upper story is divided into several very convenient sets of rooms for workpeople. Later on, it appears, further house accommodation for the workpeople will be arranged in connection with the mill; and if they are as well arranged as the rooms we had an opportunity of seeing at the time of our visit, the workpeople, who are moreover liberally paid, will have every reason to think themselves fortunate.

We will now pay a flying visit to the mill, and inspect the same and what it contains, although we after one visit hardly feel ourselves in a position to give a full and complete description of the process of manufacture. We just make the preliminary remark, that in this mill, which cost ricksdalers 500,000 (£27,750) to put up, the most modern machinery and the very best processes have been introduced.

We step, then, into the boiler-house, where we find two large steam boilers, made by Messrs. Bolinder Brothers, of Stockholm, and of the most modern construction; and in the room next it we notice three enormous globes, revolving once a minute, where the straw, after being chopped fine in the story above, is macerated by some chemical process. The pulp is then conveyed over a bridge running along the side of the house facing the river to the mill itself, to be further dealt with.

They are now busy carrying a heating apparatus from the boiler-house to the mill. In the latter building there is also a pump, made at the Gothenburg Engineering Works, which lifts 500 kannor (288 gallons) of water per minute, and supplies the whole mill with water. On the first floor in this building is situated the so-called roller room, where, up to the present time, nine roller-boxes (in which the pulp—straw and rags—is worked up and made fine) are placed, but there is room for fifteen.

Here too is a large water cistern, capable of holding 4,000 kannor (2,300 gallons).

Next to this room, we step into an enormous room intended for sorting and warehousing finished paper, and having two small rooms adjoining, one serving as the overseer's office, and the other used as a storeroom for felt, which is so requisite in the manufacture of paper. After the pulp has been duly prepared in the upper story for the further processes, it is conveyed down into the pulp vat, situated at one end of the large room on the ground-floor, where it is well stirred about, and thence passed between rollers to determine the thickness. Hence it passes through other rollers, heated, and afterwards to a machine called the "knot-catcher," where knots, lumps, and such-like, remaining from the rags, are removed by the machine.

The pulp, which is now steadily setting, next passes over a machine, where it is pressed between two sheets of brass, and afterwards into the press properly so-called, where it is pressed between two pieces of felt. From this the paper passes over four drying cylinders, and finally through the machine, which makes the surface so smooth, which is especially the case with what is produced at this mill.

At other mills each roll is made 100 ft. long and 4 ft. wide, but that made at Fiskeby is 80 ft. long and 5 ft. wide, the quantity in the rolls being the same.

In this room the paper is also marked, and a second large paper-making machine, exactly like the one now at work, is also to be set up there. The paper machine was made in Germany, but all water-wheels and driving gear at Finsporg.

In the room outside this, looking towards the river, a machine is shortly to be put up to make yellow grocers' paper, and a small engineering shop will also be fitted up.

The whole is driven by several water-wheels from 30 to 70 and 120 horse-power.

There are several enormous rooms for storing rags, and an idea may be formed of the quantity kept on hand, from the fact that there were not less than 16,000 centners (666 tons) in one room that was shown us.

On the second floor in the mill proper several persons are employed in sorting rags, and a man is at work cutting them by a machine into small pieces. In the manufacture of pasteboard they use 40 per cent. of rags to 60 per cent. of straw.

Swedish pasteboard is better than foreign, principally on account of this large percentage of rags. From the moment the straw is carried from the rickyard to be prepared for its purpose, till the time when the pasteboard, after so many and various processes, is ready to be sent out into the market, only nine hours in all elapse.

This paper mill occupies a very considerable number of workpeople, and the article produced is already in great demand, and, as we have had an opportunity of satisfying ourselves, is of most excellent quality.

The Fiskeby Mill Joint Stock Company give the following printed directions to persons using their lining pasteboard:—

"We do not consider it necessary to point out here the advantages offered by this article to consumers both in town and country, these advantages being now known and recognized by the public.

"We will only call attention to the great advantage in our lining pasteboard of its being produced in 5 ft. widths, which leads to an economy of time and trouble in putting it up. The mode of employing the pasteboard for lining houses is briefly as follows:—

"After the strips of pasteboard have been cut to the height of the room to be lined, first moisten them moderately and evenly with such paste as is used for ordinary paper for walls.

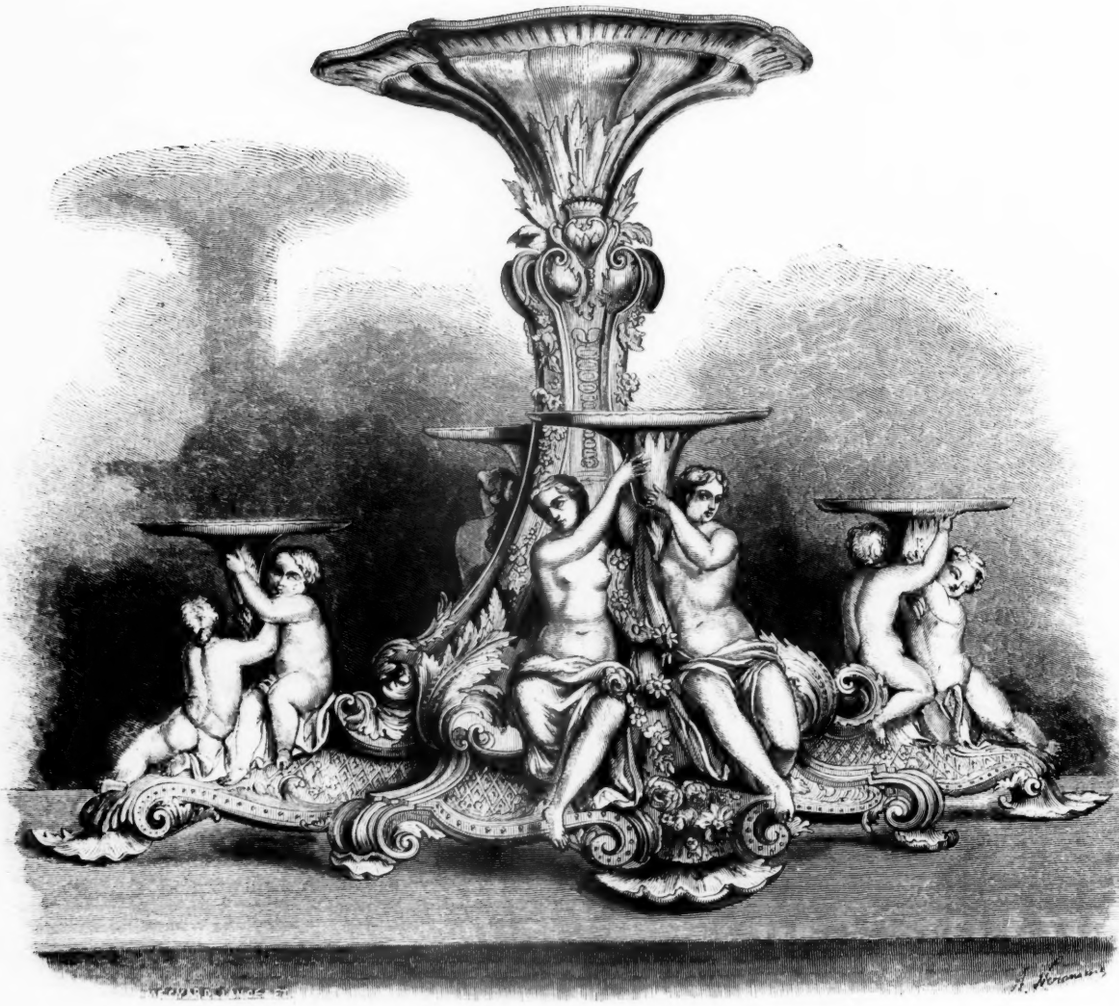
"They must lie one over the other for some hours after being wetted, so that the moisture may spread evenly over the whole surface, which ought to feel slightly damp.

"After that the ends of the pasteboard should be tacked firmly to the wall close to the ceiling and floor, with flat-headed inch nails, and the edges of the strips should lap three inches over each other. The surfaces where the overlapping seams touch should be wetted with extra strong and thick paste, made specially, and containing a little glue, and nails should be driven in both sides all down the seams, and not taken away till the joint is felt to be as dry as the remaining surface of the pasteboard.

"In order that the seams may not show through the outside paper, they should be slightly scraped down on the edge lapping over, and filled up with putty, which can be rubbed down smooth when dry. Over the seam paste a strip of paper 6 in. wide.

"After the pasteboard is thoroughly dry, the ordinary paper is to be pasted over it in the ordinary way."

[1] From the "Nya Dagligt Allehanda."



GEMS OF INDUSTRIAL ART.—EPERGNE. By M. Odiot.

(Louis XV.)

THE INDUSTRIAL CONDITION OF PRUSSIA.

(*Continued from page* 209.)

IV.—WAGES.

I HAVE extracted from various and authentic sources such information as will be found below upon the interesting and important question of the wages earned by the working classes in the chief branches of industry in Prussia. I must preface them, however, by stating, that they must be considered only as generally and approximately accurate. The only statistical data which exist, and some of which date back to four or five years ago, are not always sufficiently specific for purposes of minute statistical analysis. The rates of wages are too variously influenced by local circumstances, and by the fluctuations of trade and of the labour market, to render it possible to draw up a complete and comprehensive statement on the subject.

Some valuable and interesting information as to the rates of wages in the factories and industrial establishments of the important manufacturing town of Barmen, in the Rhenish province, contiguous to Elberfeld, has been collected and drawn up with evident practical knowledge by a resident manufacturer, and embodied in a statistical report for the years 1865 to 1867, published by order of the Town Council of Barmen.

The substance of this information is contained in the subjoined tabular statement.

RATES OF WAGES IN THE TOWN OF BARMEN IN THE YEARS 1865 TO 1867.

Trades.	Classification of Workmen.	Weekly Wages in the Years— 1865.	1866.	1867.	Hours of Work per Day.	Usual mode of Payment.	Observations.
		£ s. d.	£ s. d.	£ s. d.			
Turkey red yarn dyers	Journeymen	0 13 0	0 13 3	0 13 6	11	Weekly wages.	GENERAL OBSERVATIONS:—
	Apprentices	0 6 0	0 7 0	0 7 6	,,	,,	
	Workwomen	0 6 0	0 7 0	0 7 6	,,	,,	* As regards boys and girls (or "juvenile operatives"), the hours of labour are limited in conformity with the regulations laid down by the Industrial Code ("Gewerbe-Ordnung").
Colour dyers	Journeymen	0 13 6	0 15 0	0 15 0	,,	,,	
	Apprentices	0 6 0	0 7 6	0 7 6	,,	,,	
	Workwomen	0 6 0	0 7 6	0 7 6	,,	,,	
	,,	0 9 0	0 9 0	0 9 0	,,	Piecework.	
Dressing and finishing works	Dressers	0 18 0	1 1 0	1 1 0	,,	Weekly wages.	† The work is generally done by boys of from 15 to 17, and girls of from 16 to 20. There is a "winder" to every two looms, who earns 5s. 3d. to 6s.; this work is usually done, however, by the weaver's own family. In consequence of the high rate of wages this branch of manufacture is almost entirely ruined.
	Assistants	0 10 6	0 12 0	0 12 0	,,	,,	
	Apprentices	0 6 0	0 7 6	0 9 0	,,	,,	
Stuff printing works	Journeymen	0 12 0	0 12 9	0 13 0	11 to 11½	,,	
	Apprentices	0 6 0	0 6 9	0 6 9	,,	,,	
Piece dyers	Workmen	0 11 6	0 12 0	0 13 0	11	,,	
Bleaching works	Journeymen	0 11 3	0 12 0	0 13 6	11 to 11½	,,	
	Apprentices	0 5 3	0 6 0	0 6 9	,,	,,	
Knitting yarn and sewing thread	Workmen	0 18 0	0 18 0	0 18 0	11	Piecework.	
	,,	0 16 0	0 16 0	0 16 0	,,	Weekly wages.	
	Workwomen	0 9 0	0 9 0	0 9 0	,,	Piece work.	
	,,	0 7 6	0 7 6	0 7 6	,,	Weekly wages.	
	Boys	0 7 6	0 7 6	0 7 6	,,	,,	
Silk goods manufactory	"Jacquard" workers	0 12 0	0 12 0	0 12 0	Uncertain.	Piecework.	‡ Out of these wages are paid the journeyman and the winder; the former receives 40 per cent., and the latter usually earns 6s. to 7s. 6d. a week.
		0 18 0	0 18 0	0 18 0			
	Treadle workers	0 6 0	0 6 0	0 6 0			
		0 12 0	0 12 0	0 12 0			
Zanalla textile fabrics	Workwomen	0 9 0	0 9 0	0 9 0	11 to 11½	,,	§ A loom ("Riementisch") with machinery of the newest construction costs £270, and produces weekly sufficient of plain staple articles to enable the master to earn £3 15s. in wages. From this have to be deducted 12s. a week for the journeyman, 3s. for a winder (one-third of a week), 7s. 6d. for power and rent of premises, 3s. for oil, and 4s. 6d. for reels, scissors, &c.; so that the master clears £2 5s., and out of this he has to provide for the interest and sinking fund of the capital embarked in the concern. The machinery wears out fast, articles change often, and wages are frequently low, in consequence of which these small masters are ruined and the manufacturers set up large establishments of their own.
Lastings ditto	Workmen	0 12 0	0 13 6	0 15 0	,,	Weekly wages.	
Lasting ditto	,,	0 12 0	0 12 0	0 12 0	11	,,	
	Workwomen	0 10 6	0 10 6	0 10 6	,,	,,	
	Girls	0 9 0	0 9 0	0 9 0	,,	,,	
Cotton mill	†Weavers	0 7 6	0 9 6	0 10 0	About 12.	Piecework.	
		0 11 0	0 14 6	0 15 6			
Silk and woollen ribbon, cord, and heald manufacturers	‡Master ribbon weavers—						
	Common sorts	1 4 0	1 4 0	1 4 0	?	,,	
	Better sorts	1 16 0	1 16 0	1 16 0	?	,,	
	Finest sorts	3 0 0	3 0 0	3 0 0	?	,,	
	Workmen	0 10 6	0 10 6	0 10 6	13	Weekly wages.	
		0 15 0	0 15 0	0 15 0			
	Workwomen	0 9 0	0 9 0	0 9 0	,,	,,	
	Female reel workers	0 10 6	0 10 6	0 10 6	,,	,,	
	Factory hands—						
	Workmen	0 10 6	0 10 6	0 10 6	10½	,,	
		0 12 0	0 12 0	0 12 0			
	Workwomen	0 9 0	0 9 0	0 9 0	,,	,,	
	§Master working with his own loom	...	...	...	...	...	
	‖Tape weaver with his own loom	0 12 0	0 18 0	0 16 6	12	Piecework.	‖ These wages include an agreement that the wife and children undertake to do all the necessary handiwork and to wind the woof. The labour may be set down as worth 1s. 2½d. to 2s. 6d. a week.
		0 15 0					
	Factory hands—						
	Workmen	0 9 0	0 9 0	0 9 0	10½	Weekly wages.	
		0 11 3	0 11 3	0 11 3			
	Workwomen	0 7 6	0 7 6	0 7 6	,,	,,	
	Boys	0 3 0	0 3 0	0 3 0	,,	,,	
		0 6 0	0 6 0	0 6 0			
India-rubber manufactories	I. Power loom weavers—						¶ They have to pay the journeyman out of these wages, at the rate, according to their work, of 1s. 2½d. to 1s. 6d. for every 3s. which they receive, and they have also to pay the winders.
	a. Journeymen	0 13 6	0 14 0	0 14 3	10½	,,	
	b. ,,	0 13 6	0 13 6	0 13 6	,,	,,	
	,, lowest piecework	0 15 0	0 15 0	0 15 0	,,	Piecework	
	,, highest ,,	1 13 0	1 13 0	1 13 0	,,	,,	
	c. Winders—Workmen	0 10 6	0 10 8	0 10 6	,,	,,	
		0 12 9	0 12 9	0 12 9			
	,, Workwomen	0 9 0	0 9 0	0 9 0	,,	,,	
	,, Boys	0 7 6	0 7 6	0 7 6	,,	,,	
		0 9 0	0 9 0	0 9 0			
	II. Factory hands—						
	Binding room	0 12 0	0 12 0	0 12 0	10½	Weekly wages.	
		0 18 0	0 18 0	0 18 0			
	Cutting room	0 9 0	0 9 0	0 9 0	,,	,,	
		0 13 6	0 13 6	0 13 6			
	Workwomen (reel workers)	0 7 6	0 8 3	0 9 0	,,	,,	
	¶III. Outworkers	1 4 0	1 4 0	1 4 0	,,	?	
		2 8 0	2 8 0	2 8 0			
	,, hand winders	0 4 6	0 4 6	0 4 6	,,	?	
		0 7 6	0 7 6	0 7 6			
	,, machine winders	0 6 0	0 6 0	0 6 0	,,	?	
		0 12 0	0 12 0	0 12 0			
Soap and candle manufactories	Workmen	0 12 0	0 12 0	0 12 0	11	Weekly wages.	
	Workwomen	0 7 0	0 7 0	0 7 0	,,	,,	
Chemical works	Workmen—					,,	
	At the reverberating furnace	1 0 0	1 0 0	1 0 0	10½	,,	
	At the pyrites furnace	0 16 6	0 16 6	0 16 6	,,	,,	
	At the sulphate furnace	0 16 6	0 16 6	0 16 6	,,	,,	
	At other processes	0 14 3	0 14 3	0 14 3	,,	,,	
		0 16 6	0 16 6	0 16 6			

Trades.	Classification of Workmen.	Weekly Wages in the Years— 1865.	1866.	1867.	Hours of Work per Day.	Usual mode of Payment.	Observations.
		£ s. d.	£ s. d.	£ s. d.			
Chemical Works *(Continued)*	Handicraftsmen	½ 0 15 0	0 15 0	0 15 0	½ 10½	Weekly Wages.	
		½ 0 16 6	0 16 6	0 16 6	½		
	Drivers	0 13 6	0 13 6	0 13 6		,,	
	Helpers	0 12 9	0 12 9	0 12 9		,,	
Iron, steel, and hardware manufactories	Smiths	0 15 0	0 15 0	0 15 0	11	,,	
		½ 0 12 0	0 12 0	0 12 0	½	,,	
		½ 0 15 0	0 15 0	0 15 0	½	,,	
	Average workmen	0 12 0	0 12 0	0 12 0		,,	
	Journeymen	0 7 10	0 7 10	0 7 10		,,	
	Apprentices	½ 0 4 6	0 4 6	0 4 6	½	,,	
		½ 0 9 0	0 9 0	0 9 0	½	,,	
Iron foundries	Moulders	0 15 0	0 15 0	0 15 0		,,	
	Journeymen	0 11 0	0 11 0	0 11 0		,,	
Boiler and machine makers	Turners and locksmiths	0 15 0	0 15 0	0 15 0	12	,,	
	Boiler smiths	0 15 0	0 15 0	0 15 0		,,	
	Smiths	½ 0 16 6	0 16 6	0 16 6	½	,,	
		½ 0 18 0	0 18 0	0 18 0	½	,,	
	Hammerers	½ 0 12 0	0 12 0	0 12 0	½	,,	
		½ 0 13 6	0 13 6	0 13 6	½	,,	
	Apprentices	½ 0 7 6	0 7 6	0 7 6	½	,,	
		½ 0 10 6	0 10 6	0 10 6	½	,,	
Percussion cap manufactories	Workmen	0 16 6	0 16 6	0 16 6	10½	,,	
	Workwomen	0 8 3	0 8 3	0 8 3	,,	,,	
Button manufactories	Boys and girls	½ 0 3 0	0 3 0	0 3 0	½ *	Piecework.	
		½ 0 4 6	0 4 6	0 4 6	½		
	Boys and girls from 17 to 20 years of age	½ 0 6 0	0 6 0	0 6 0	½ 11	,,	
		½ 0 8 6	0 8 6	0 8 6	½		
	Cutters	½ 0 10 0	0 10 0	0 10 0	½	,,	
		½ 0 13 0	0 13 0	0 13 0	½	,,	
	Stampers, polishers, &c.	½ 0 13 6	0 13 6	0 13 6	½	,,	
		½ 0 18 0	0 18 0	0 18 0	½	,,	
	Turners	½ 0 18 0	0 18 0	0 18 0	½	,,	
		½ 1 4 0	1 4 0	1 4 0	½	,,	
Plating works	Boys and girls	0 5 2	0 6 0	0 6 6	*	Weekly wages.	
	Workmen	0 15 0	0 15 9	0 16 0	?	,,	
Whip manufactories	Boys and girls	0 6 0	0 6 7	0 6 7	*	,,	
	Workmen	0 10 6	0 11 3	0 11 3	11	,,	
Pianoforte manufactory and organ building	Pianoforte makers	0 15 0	0 17 3	0 16 10	?	?	
	Organ builders	0 14 6	0 15 11	0 17 6	?	?	
	Other workmen	0 12 4½	0 13 6	0 15 0	?	?	
Lithographic establishments	Workmen	0 15 0	0 15 0	0 15 0	10½	Weekly wages.	† These wages are exclusive of Board and lodging, which are provided by the employer.
Letter-press printing offices	Type setters	0 16 6	0 16 6	0 18 0	10	,,	
	Printers at daily wages	0 12 0	0 12 0	0 12 0	,,	,,	
Bookbinding	Workmen	0 12 0	0 12 0	0 12 0	11½	,,	‡ The hours of work are shorter in winter, and the wages proportionately less.
	† ,,	0 5 0	0 5 0	0 5 0	,,	,,	
Masons, builders, brick makers, plasterers	Journeymen masons	0 12 0	0 13 2½	0 14 6	‡12	,,	§ These wages are paid for each hour's work.
	Assistants	0 9 0	0 9 9	0 10 6	,,	,,	
	Carpenters	0 12 0	0 13 6	0 14 6	‡13	,,	
	Well makers	0 15 0	0 15 0	0 15 0	12	Piecework.	
Carpenters	Journeymen	0 10 6	0 12 0	0 13 6	,,	Weekly wages.	
Painters, glaziers, &c.	,,	0 10 6	0 11 3	0 12 0	‡11	,,	
Turners	† ,,	0 3 0	0 3 0	0 4 6	12 to 13	,,	
Tinmen, varnishers, &c.	† ,,	0 4 6	0 5 0	0 5 0	,,	,,	
Coppersmiths, braziers, &c.	† ,,	0 4 6	0 5 3	0 6 0	13 to 14	,,	
	,,	0 10 6	0 11 3	0 12 0	12	,,	
Tailors	† ,,	0 4 0	0 5 0	0 6 0	13 to 14	,,	
	,,	0 12 0	0 13 6	0 15 0	,,	Piecework.	
Capmakers	† ,,	0 4 6	0 5 3	0 6 0	,,	Weekly wages.	
Shoemakers	† ,,	0 3 0	0 3 9	0 4 6	13	,,	
	† ,,	0 6 0	0 6 9	0 7 6	,,	Piecework.	
Saddlers	† ,,	0 4 0	0 4 0	0 4 6	,,	Weekly wages.	
Bakers	† ,,	0 3 6	0 4 0	0 4 6	?	,,	
Brewers	† ,,	0 4 6	0 5 3	0 6 0	?	,,	
Coopers	† ,,	0 4 0	0 4 0	0 4 0	12½ to 13	,,	
Slaters	† ,,	0 4 6	0 6 0	0 7 6	‡12½	,,	
Millers	,,	0 12 0	0 12 9	0 13 6	13	,,	
Ropemakers	† ,,	0 3 6	0 3 6	0 3 6	,,	,,	
Wheelwrights, framemakers	† ,,	0 3 0	0 3 0	0 3 9	,,	,,	
Watchmakers	† ,,	0 4 6	0 5 3	0 6 0	11 to 12	Weekly wages, paid by month.	
Jewellers	† ,,	0 6 0	0 6 0	0 6 0	12	Weekly wages.	
Barbers, hairdressers	† ,,	0 3 0	0 3 0	0 3 0	?	,,	
Jobmasters and carriers	†Drivers and carters	0 4 6	0 5 0	0 6 0	Uncertain.	,,	
Gardeners	§Workmen	0 0 2½	0 0 2½	0 0 2½	,,	By the hour.	
Locksmiths	†Journeymen	0 4 6	0 5 3	0 6 0	12 to 13	Weekly wages.	
	,,	0 12 0	0 12 9	0 13 6	,,	,,	

GENERAL OBSERVATIONS:—

* As regards boys and girls (or "juvenile operatives"), the hours of labour are limited in conformity with the regulations laid down by the Industrial Code ("Gewerbe-Ordnung").

TABLE OF WAGES IN IRON TRADE UPPER SILESIA.

Mines and Works.	Class of Workmen.	Wages per day.	Hours per Day.	Observations.
		s. d.		
Coal mines	Pitmen	1 11½	12	At one of the blast furnaces wages are regulated by the weekly produce of the furnace, and the weekly wages earned are as follows: Smelters, 12s. 8½d. to £1 1s. 11d. Chargers of furnaces, 10s. 11d. to 13s. Barrow men, 7s. 2½d. to 12s. 6d.
	Haulers ("Schlepper")	1 7½	12	
		s. d. s. d.		
Coke works	Workmen	1 3½ to 1 6	11	
	Workwomen	0 9½ 1 0	12	
Blast-furnaces	1st class smelters	2 9 3 0	12	
	2nd class ditto	2 3 2 6	12	
	Chargers of furnaces	1 11 2 2½	12	
	Barrow men, &c	1 6 1 8½	12	
	Boiler men	1 3½ 1 6	12	
	Engine men	1 9 2 0		
Iron rolling works	1st class workmen at the puddling furnaces	... 4 0	12	
	2nd class ditto	... 2 3	12	
	3rd class ditto			
Iron foundries	Moulders and assistant casters	... 2 1¾	12	
		27½ 3 0	12	
Masters directing the workmen at two cupola furnaces receive a monthly salary of £5 5s., with a percentage of ¾d. per cwt. of finished castings, altogether from £10 10s. to £12 15s. a month.				

Further particulars relating to the wages paid in the mines and ironworks of Upper Silesia, collected by Mr. Overgens, a civil engineer, in a professional tour which he made in August, 1868, have been obligingly placed at my disposal. They are as in the foregoing table.

The periodical published by the Statistical Bureau of Berlin in 1868 contains (page 326) a paper written by Privy Councillor Jacobi, entitled "Wages in Lower Silesia." A reproduction (for the nature of the subject baffles analysis) of the voluminous details, extending to various branches of manufacture and trade, would swell this report to unreasonable limits, and I must content myself, therefore, with indicating the source where detailed information on the subject is to be found.

The following particulars, showing the number of workpeople employed and the rates of wages which they earn in different branches of industry in Prussia, are extracted from the reports of the Chambers of Commerce for the years 1867 and 1868:—

Province, Place.	Manufactories, &c.	Number of Workpeople Employed and Rates of Wages.
Province of Silesia—		
Breslau	Machine manufactory	316 workmen; average daily earnings, 2*s.* 1½*d.*
Königshuld	Wrought-iron goods	117 workmen; average yearly wages, £18 9*s.*
	Glass manufactory	200 workmen; daily wages, 1*s.* to 3*s.*
Münsterberg	Chemical works	150 workmen; daily wages, 1*s.* to 2*s.* 9*d.*
	Coke works	20 workmen; daily wages, 1*s.* to 1*s.* 6*d.*
Breslau	Chemical manure works	80 to 90 workmen; daily wages, males, 1*s.* 2*d.* to 3*s.*, females, 6½*d.* to 1*s.*
Ohland	5 cigar manufactories	350 males and females; weekly wages, 2*s.* to 15*s.*
Breslau	Woollen yarn manufactory	16 males, 6 females; weekly wages, 7*s.* 6*d.* to 18*s.*, and 4*s.* to 6*s.*
Schmiedeberg	Carpet manufactory	50 males, 200 females; weekly wages, 7*s.* 6*d.* to 12*s.*, and 3*s.* 9*d.* to 6*s.*
Hirschberg	Lace-bobbin mill	Lacemakers (females); weekly wages, 3*s.* to 6*s.*
Görlitz	Glass works	200 workmen; daily wages, 1*s.* to 3*s.*
Landeshut	Sulphur mine	58 workmen; daily wages, 8¾*d.* to 1*s.* 3½*d.*
	Coal mine	52 workmen; daily wages, 1*s.* 3½*d.* to 1*s.* 11½*d.*
Lauban	Chemical bleach yard	40 workmen; weekly wages, 7*s.* 6*d.* to 9*s.*
	Anthracite mine	120 workers and 65 drift and earth workers; average wages, £30 and £70 a-year.
Gozolin	Lime kiln	Daily wages, 1*s.* to 1*s.* 2½*d.*
Altwasser	Porcelain manufactory	1,500 workmen; weekly wages, average 10*s.* 6*d.* to 12*s.*
Rauscher	Glass works	180 workmen; daily wages, 1*s.* to 3*s.*
Merzdorf	Chemical works	Wages, 10*d.* to 1*s.* 5*d.* a-day.
	Sulphuric acid works	Wages, 10*d.* to 1*s.* 5*d.* a-day.
Waldenburg	Coke works	Wages, 1*s.* to 1*s.* 6*d.* a-day.
Schmiedeberg	Shawl, plush and chenille manufactory	Wages, 3*s.* 9*d.* to 15*s.* a-week.
Reinerz	Shoe tacks, &c.	Wages, by piecework, for grown-up workmen, 8½*d.* to 2*s.*, for youths, 5½*d.* to 9½*d.*
Province of Brandenburg—		
Berlin	Carriage manufactory	1,416 workmen; average yearly wages, £49 16*s.*
Province of Saxony—		
Magdeburg	Cotton spinning factory	318 workmen; total yearly wages, £5,741, average per head, £18.
	7 machine manufactories	934 ,, ,, £41,438, ,, £44 8*s.*
Bückau	1 ditto	400 ,, ,, £14,641, ,, £35 8*s.*
Province of Hanover—		
Lüneburg	Saltworks	119 ,, ,, £2,715, ,, £23 16*s.*
	Iron smelting furnace	238 ,, ,, £6,846 9*s.*, ,, £28 16*s.*
	Lime pit	64 ,, ,, £804, ,, £12 12*s.*
	Cement manufactory	100 to 130 ,, ,, £3,750, ,, £34 1*s.*
	Soda manufactory	100 ,, ,, £3,150, ,, £31 10*s.*
	Artificial manure manufactory	25 ,, ,, £480, ,, £19 4*s.*
	Mohair manufactory	120 ,, ,, £3,450, ,, £23 16*s.*
	Paper manufactory	8 to 10 ,, ,, £375, ,, £20 1*s.*
	Paper hangings manufactory	50 to 60 ,, ,, £1,320, ,, £24.
	Gas factory	11 ,, ,, £282 12*s.* ,, £25 13*s.*
Geestemünde	Pottery	300 workmen; weekly wages, average 10*s.*
Göttingen	Cigar manufactory	Weekly wages, average 7*s.* 6*d.*
	India-rubber works	80 to 100 workmen; total weekly wages nearly £45, average per head 9*s.* to 10*s.* 6*d.*
Hanover	Cotton mill	1,400 to 1,500 workpeople; total yearly wages, £28,500 to £30,000, per head, £20 5*s.*
Werden district	Cigar manufactory	1,500 workpeople; wages average 2*s.* 6*d.* to 3*s.* a-day.
Province Westphalia—		
Iserlohn	Puddling and rolling works	900 workmen; average weekly wages, 12*s.* to 13*s.* 6*d.*
Province Hesse-Nassau—		
Limburg	Phosphates of lime mines	Daily wages for contract work, 1*s.* 6*d.* to 2*s.*
	Ore mining—working	568 workmen; annual total of wages, £12,453 12*s.*, average for each workman, £21 18*s.*
	,, smelting	342 ,, ,, £3,152 ,, ,, £9 3*s.*
	,, dressing	66 ,, ,, £1,640 17*s.*, ,, ,, £24 18*s.*
Wiesbaden	Mines	Daily wages for cutters (12 hours), 1*s.* 10½*d.*; workers, 1*s.* 2½*d.* to 1*s.* 5*d.*; apprentices, 9½*d.* to 1*s.* (averages).
	Cigar manufactory	Weekly wages for men, 12*s.* to 15*s.*; for youths and girls, 5*s.* and 6*s.*
Hanau	Engine manufactory	Weekly wages, workmen, 11*s.* 5*d.* to 12*s.*; day workers, 8*s.* 6*d.* to 9*s.* 6*d.* a week; apprentices, 3*s.* 5*d.*
	Hardware manufactory	Weekly wages, workmen, 10*s.* 1½*d.* to 18*s.* 9*d.*; day workers, 7*s.* 6½*d.* to 9*s.* 6*d.* a-week; apprentices, 4*s.* 3*d.*
	Plated metal works	Weekly wages, workmen, 12*s.* to 13*s.* 8*d.*; day workers, 8*s.* 6*d.* a-week; apprentices, 6*s.*
	Goldsmiths' and silversmiths' work	Weekly wages, males 10*s.* 3*d.* to 24*s.*; female, 6*s.* to 10*s.* 3*d.*; male apprentices, 1*s.* 8*d.* to 6*s.*; female apprentices, 1*s.* 8*d.* to 5*s.* 1*d.*; day workers, 6*s.* 10*d.* to 12*s.*
	Gold and silver wire and manufactured goods	Weekly wages, men, 3*s.* 5*d.* to 12*s.*; women, 14½*d.* to 5*s.* 2*d.*
	Gas works	Weekly wages, workmen, 12*s.* 5*d.*
	Tobacco manufactories	Weekly wages, males, 10*s.* 3*d.*; women, 8*s.* 1*d.*; young persons, 5*s.* 1*d.*
	Hat manufactories	Weekly wages, males, 15*s.* 5*d.* to 18*s.*; women, 3*s.* 5*d.* to 8*s.* 6*d.*; apprentices, 1*s.* 8*d.* to 5*s.* 1*d.*; and day workmen, 6*s.* 10*d.* to 8*s.* 6*d.* a-week.
	Cigar-box manufactories	Weekly wages, workmen, 6*s.* 10*d.* to 20*s.* 6*d.*
	Paper manufactories	Weekly wages, men, 10*s.* 3*d.*; women, 5*s.* 1*d.*, on the average.
Rhenish Province—		
Stolberg	Iron works ("Rothe Erde")	791 workmen; daily wages averaging 2*s.* 7*d.*
Düsseldorf	Engine manufactory	53 workmen; weekly wages averaging 13*s.* 6*d.*
	Wire tacks manufactory	Daily wages for men, 2*s.* to 3*s.*; youths, 7¼*d.* to 1*s.*
	Calico print works	Daily wages for men, 1*s.* 8*d.* for 12 hours.
	India-rubber manufactory	Weekly wages, 6*s.* to 8*s.*
Saarbrück	Government coal mines	18,646 workmen (in 1867); yearly sum paid for wages, £651,666, average per head, £34 18*s.*; for every 5 tons of coals raised, 20*s.* 6¾*d.*
Essen	Blast-furnaces	201 workmen; daily average wages, 2*s.* 8½*d.*
Mülheim	Coal mines	3,601 ,, ,, 2*s.* 2¾*d.* to 2*s.* 8*d.*
	Blast-furnaces, &c.	460 ,, ,, 2*s.* 4¾*d.*, average annual wages, £30 9*s.*
	Iron works	473 ,, ,, 2*s.* 8½*d.*
	Wrought-iron manufactures	60 ,, ,, 2*s.* 4*d.*
	Zinc works	352 workmen; yearly sum paid for wages, £14,754; per head, £42; smelter, 1st class, daily wages, 3*s.* 11*d.*; 2nd class, 3*s.*; other workmen, 2*s.* 2½*d.*

Province, Place.	Manufactories, &c.	Number of Workpeople Employed and Rates of Wages.
Mülheim *(continued)*.	Cotton weaving and printing	435 men, women, boys, and girls; daily wages, average, 1*s.* 8*d.*
	Cotton spinning factory	105, chiefly boys and girls and females; average daily wages, 1*s.* 6*d.*
Saarn	Wooden and carriage screw manufactory	67 workmen; yearly sum paid in wages, £1,125; average per man, £16 16*s.*
Duisburg	Blast furnaces	246 workmen; smelters' daily wages, 2*s.* 8*d.* and 3*s.*; day workmen, 1*s.* 9½*d.*; locksmiths and enginemen, 2*s.* 5*d.*
	Ditto	258; daily wages for workmen, 1*s.* 7*d.* to 1*s.* 9½*d.*; men employed at the furnaces, 2*s.* to 3*s.*; coke-burners, 2*s.* 6*d.* to 3*s.*
	Cast-steel works	25; average daily wages, 2*s.* 6*d.*
	Fire-proof stoneware	105; yearly sum paid in wages, £3,998 8*s.*; average per head, £38 2*s.*
	Shipbuilding yard	12; average daily wages, 2*s.* 11*d.*

The following particulars with respect to the rates of wages in the glass trade, and in the mining and metallurgic industries, are extracted from a variety of official returns furnished by the provincial governments, but they refer for the most part to the year 1860:—

I.—*Rates of Wages and Earnings in the Glass Trade.*

	£	s.	d.		£	s.	d.
Province of Brandenburg:							
Town of Templin—							
Weekly wages	0	15	0	to	0	18	0
Province of Rhine:							
District of Saarlouis—							
Yearly earnings of a glass-maker	26	0	0			...	
Ditto, of a journeyman	22	10	0			...	
Ditto, glass-blower	15	0	0			...	
Ditto, apprentice	7	10	0			...	
Ditto, stoker and case-maker	22	10	0			...	
Ditto, glass-grinder (master)	24	0	0			...	
Ditto, ditto (journeyman)	18	0	0			...	
Ditto, ditto (apprentices)	4	10	0			...	
District of Saarbrück—							
Glass-blowers earn annually	33	0	0			...	
Rollers, ditto	22	10	0			...	
Stokers, melting-pot, and case-makers, mixers of composition, and glass-cutters	18	0	0			...	

II.—*Rates of Wages and Earnings of Miners.*

	s.	d.		s.	d.
Province of Silesia:					
The daily wages in Waldenburg average	1	6			
Ditto, in Schönau	1	0	to	1	6
Ditto, in Bolkenhain	1	0		1	2½
Ditto, in Frankenstein	0	8¼		1	1¼
District of Stenrode—					
Daily wages of miners, of 17 to 25 years old	0	9½		1	5
Ditto, from 25 and upwards	1	2½		1	6
Miners who keep house receive 12*s.* worth of coals annually.					
District of Lublintz—					
Daily wages, with lodging and firing, and the use of from 1 to 5 morgen of land (the morgen equal to 1½ acre)	0	6		1	0
Pless—					
Cutters	1	2½		2	0
Province of Saxony:					
District of Sangerhausen—					
Wages for 8 hours' task work, average	1	0			...
District of Erfurt—					
Average daily wages	1	6			...
District of Ochersleben—					
Wages for 12 hours' task work for cutters	1	5		1	9½
Ditto, for able-bodied workers	1	2½		1	5
Ditto, for youths	0	9		1	2½
Rhenish Provinces:					
District of Essen—					

Workmen.	Number of Working Days in the year.	Northern part of the District. Task Work of 6 to 8 hours. Wages.	Northern part of the District. Annual Earnings.	Northern part of the District. Task Work of 6 to 8 hours.	Northern part of the District. Annual Earnings.
		s. d.	£ s.	s. d.	£ s.
Cutters	300	1 11½	29 8	2 5½	33 0
Drawers	300	1 8	24 15	1 9½	27 0
Engine men	336	...	32 8	2 4½	31 18
Stokers	336	...	28 16	1 8½	28 9
Watchmen	348	1 0	18 0	1 3½	23 8
Workmen	300	1 6	22 10	1 6	22 10
Boys	300	0 11	13 10	1 0	15 0
Other workmen	300	1 6	22 10	1 6	22 10

	£	s.	d.		£	s.	d.
District of Duisburg—							
Miners and smelters, according to their work, and the nature of their employment, earn, annually	22	10	0	to	36	0	0
District of Nettman—							
A miner earns daily	0	2	5	to	0	3	0
A day workman, ditto	0	1	9½		0	2	0
A youth, ditto	0	1	1		0	1	7
District of Mülheim—							
The average wages for 12 hours' task work are	0	1	6			...	
District of Engen—							
Monthly earnings	1	16	0		2	5	0
District of Schleiden—							
Weekly earnings	0	9	0		0	10	6
Districts of Adenau and Zell—							
Average daily wages	0	1	2½			...	
District of Ottweiler—							
The following are the wages in the Government coal mines:—							

Workmen.	For 12 hours' Task Work. In the Mines.		For 8 hours' Task Work in the Mines.
	s. d.	s. d.	s. d.
Mine carpenters ("Zimmerhauer")	1 1½	2 0	1 9
Cutters	1 10	1 9	1 6
Workers and drawers—			
First class	1 8½	1 7½	1 5
Second class	1 7	1 6	1 3½
Third class	1 6	1 5	1 2½
Fourth class	1 5	1 3½	1 1¼
	s. d. s. d.	s. d. s. d.	s. d. s. d.
Signalmen, &c.	1 8 to 2 1¼	1 9 to 2 0	1 5 to 1 9

III.—*Rates of Wages and Earnings in the Metallurgic Industry.*

	£	s.	d.		£	s.	d.
Province of Silesia:							
District of Sprottau—							
Weekly wages for moulders and apprentices in the iron works	0	6	0	to	0	15	0
Ditto, for engine-makers and locksmiths	0	15	0		1	10	0
District of Waldenburg—							
Weekly wages for smelters, at the lowest	0	6	0		0	9	0
District of Frankenstein—							
Average daily wages	0	0	8½		0	1	1¼
District of Glatz—							
Average daily wages	0	1	0			...	
District of Pless—							
Daily wages for ordinary task workmen	0	0	9½		0	1	2¼
Ditto, for smelters, smiths, and skilled workmen	0	1	0		0	2	3
Province of Saxony:							
District of Stendthal—							
Daily wages for ordinary workmen	0	1	0			...	
Ditto, for smelters	0	1	6			...	
Ditto, ditto, on the average and for contract work:—							
For the former	0	1	6			...	
For the latter	0	2	0			...	
Province of Westphalia:							
District of Konsfeld—							
Daily wages	0	0	7		0	3	0
Rhenish Province:							
Wages throughout the various iron works vary, according to the nature of the works themselves, and to the skill and energy of the workmen, from, per day	0	0	7		0	3	0
In the district of Essen the following are the rates of wages per day—							
1. Workmen with daily employment, viz.:							
Master smelters	0	4	0			...	
Smelters	0	2	0			...	
Loaders	0	1	7½			...	
Weighers	0	1	9½			...	
Scoria drawers ("Schlachenzieher")	0	1	8½			...	
Engineers	0	4	0			...	

	£	s.	d.	£	s.	d.
Sub-engineers	0	1	9½		...	
Coke-burners	0	2	1½		...	
2. Workmen who are only employed on work-days:						
Limestone-heaters	0	1	6		...	
Labourers	0	1	6		...	
Smiths	0	2	4½		...	
Carpenters	0	2	0		...	
Masons	0	3	0		...	
The usual wages for task work in the zinc works are 1s. 9½d. a-day, rising, according to increased rate of production and activity, in particular works.						
Smelters earn	0	1	7 to	0	3	6
Stokers	0	1	11	0	3	2½
Muffle-makers	0	2	5		...	
Masons	0	2	1½		...	
Carpenters	0	2	2½		...	
Workmen employed by the day	0	1	9½		...	
Youths	0	1	0	0	1	5
Men employed at the furnaces, a-day	0	1	9½	0	2	6
In the machine manufactories the men are paid by task work at the following rates:						
Day workmen	0	1	4½	0	1	6
Loam and sand-moulders	0	0	9½	0	2	5
Wooden model-makers	0	1	7½	0	2	5
Turners in metal	0	1	7½	0	2	3½
Locksmiths	0	1	7½	0	2	5
Smiths	0	1	7½	0	2	6
Youths	0	0	9½	0	1	2½
In Krupp's cast-steel works wages vary according to the different branches of work and the relative skill of the workmen.						
Day workmen or helpers ("Handlanger") receive, per day	0	1	2½	0	1	9½
Smiths, smelters, puddlers, carpenters, masons, &c., receive, per month, wages varying from	2	8	0	6	15	0
Masters (with various additional advantages), per month	6	0	0	9	0	0
The number of workmen employed in Krupp's establishment is between 8,000 and 10,000.						
In the district of Gummersbach—						
Men employed in the iron works receive, per day	0	1	6	0	2	0
In the district of Düren—						
In the smelting establishments and machine manufactories, weekly	0	9	0	0	10	6
In the district of Adenau—						
In the smelting establishments and machine manufactories, men in permanent employment, per day	0	1	0		...	
In the district of Zell—						
In the smelting establishments and machine manufactories, men in permanent employment, per day	0	1	6		...	
In the district of Treves—						
The iron-workers receive annually, according to the classes to which they belong:—						
First class	33	15	0	39	0	0
Second class	27	15	0	33	15	0
Third class	22	10	0	27	15	0
Fourth class	16	16	0	22	10	0
Fifth class	11	5	0	16	16	0
Sixth class	9	0	0	11	5	0
For 280 working days in the year.						
In the district of Altweiler—						
In the Neukirchner iron works day-workmen earn	0	1	9½		...	
Youths,	0	1	2½		...	
Apprentices of from 14 to 16 years of age	0	0	9½	0	1	5
Workmen employed at the blast-furnaces	0	1	5	0	3	0
Puddlers and smelters, per day	0	1	2½	0	4	6
The same rate of wages prevails in the engine manufactories.						
In the district of Saarbrück—						
The average daily wages for task work in the iron works are as follows:—						
Masters of all classes (welders, rollers, melters, smelters, hammerers, smiths, puddlers, railmakers, machinists), and working machinists of the first class, earn, per day	0	3	0		...	
Puddlers of the second class, melters, welders, foremen rollers, railmakers' assistants, pincers holders, and assistant workmen of the second class, earn, per day	0	2	0		...	
Third class—Boiler-feeders, stokers, assistant workmen, and all other workmen employed in this class, earn, per day	0	1	6		...	

	£	s.	d.	£	s.	d.
District of Saarlouis—						
The annual earnings of those employed in the iron works are as follows:—						
Master puddlers	45	0	0		...	
Master welders, rollers, smelters, hammermen and decorators	30	0	0 to	36	0	0
First class puddlers	30	0	0		...	
Second class ditto	22	10	0		...	
First class welders and rollers	25	10	0		...	
Second class ditto	21	0	0		...	
First class smelters	22	10	0		...	
First class refiners and decorators	22	10	0	24	0	0
Second class ditto	18	0	0	19	10	0
Ordinary workmen	15	0	0	18	0	0

With respect to the returns which I have given above, showing the average wages paid in many of the chief branches of the manufacturing and mining industries situated in the principal industrial centres of Prussia, I must observe, that the conditions of labour, and the relations between employers and their workmen, vary so much in different trades, that it is next to impossible to give any general correct summary of them. The Industrial Code ("Gewerbe-Ordnung") for the North German Confederation, an Act passed during the present year, in Part VII. sets forth the reciprocal obligations and duties of employers and employed, and traces the legal limits within which both are allowed unrestricted freedom to combine for the protection or advancement of their interests, real or imaginary.

(Signed) GEORGE PETRE.

INDUSTRIAL CODE ("GEWERBE-ORDNUNG") OF THE NORTH GERMAN CONFEDERATION, JUNE 21, 1869.

PART I.—GENERAL PROVISIONS.

§ 1. Everyone is at liberty to exercise a trade or calling, subject to such exceptions or limitations as are prescribed by the present law.

No one actually entitled to exercise a trade or calling can be deprived of that right on the ground of not fulfilling the conditions prescribed by the present law.

§ 2. The distinction between town and country, as regards the exercise or extension of the limits of a trade or calling, is abolished.

§ 3. More than one trade may be carried on at a time by the same person, or the same trade may be carried on in more than one workshop or place of sale. No restriction is placed upon the sale by artizans of goods which are not of their own manufacture.

§ 4. Guilds and commercial corporations have no right of excluding others from exercising a trade.

§ 5. No change is made by the present law in respect to the restrictions which are imposed upon the exercise of certain trades or occupations in virtue of the Customs, Excise, and Postal Laws.

§ 6. The present law does not apply to mining concerns (except in so far as provided in §§ 152, 153, 154), to fisheries, to the practice of medicine (subject to the provisions contained in §§ 29, 30, 53, 80, 144), to the establishment and removal of apothecaries' shops, and the sale of drugs (subject to the provisions contained in § 80), to educational matters, to the practice of the law, and conveyancing business, to the business of emigration agencies, insurance offices, and railway undertakings, to the sale of lottery tickets, to the right of keeping public conveyances, or to the legal status ("Rechtsverhältnisse") of ships' crews.

An ordinance of the Federal Presidency will determine in what drugs unrestricted trade is to be permitted.

§ 7. From the 1st of January, 1873, unless the laws of a state prescribe that it shall have effect at an earlier date, are abolished:

1. All surviving exclusive industrial privileges ("Gewerbeberechtigungen"), that is to say, rights in connection with the exercise of a trade, of preventing others from the exercise of the trade, or of imposing restrictions upon it, whether in a general way, or with reference to the use of certain materials employed in it.

2. "Zwangs" and "Bann"[1] rights which are coupled with exclusive trade privileges, with the exception of the skinners' rights.

3. All "Zwangs" and "Bann" rights which, by the terms of their charters, can be abolished without indemnity.

4. The following rights, if not already abrogated by the pre-

[1] "Zwangs- und Bannrechte." The ancient rights under which the inhabitants of a certain district, living within the "Bann" (mile), were compelled to employ particular millers, bakers, butchers, brewers, &c.

ceding clauses, and if not resting upon a contract between the parties holding them and the parties subject to them :—

(*a.*) The right attached to the possession of a mill, distillery, or right of distillery ("Brenngerechtigkeit"), a brewery or right of brewery, or a tavern, or of forcing consumers to employ exclusively the persons in possession of these rights, to grind or bruise their corn and to supply them with drink (termed the "Mahlzwang," "Branntweinzwang," or "Branzwang").

(*b.*) The right possessed by the butchers and bakers of a town of compelling the inhabitants of the town, suburbs, or district, called the "Bann" mile, to supply themselves entirely or partially with meat and bread from them.

5. Rights of granting concessions for industrial establishments or for the exercise of trades, whether vested in the treasury, corporations, institutions, or in individual holders.

6. All imposts levied upon the exercise of a trade, as also the right of levying them, with the exception of the trade taxes payable to the state and the communes.

The laws of each state are to determine whether, or to what extent, the holders of the aforesaid exclusive trade rights are to be indemnified for their abolition.

§ 8. From the said period (§ 7), unless the laws of the state prescribe an earlier date, are subject to redemption :

1. All such "Zwang" and "Bann" rights as are not abrogative by § 7, in so far as the obligation rests upon landed property, or concerns the members of a corporation as such, or is imposed upon the inhabitants of a locality or district in virtue of their domicile.

2. The right of compelling the proprietor of a tavern to resort to a particular brewery for the drink required in his establishment.

The special arrangements for redeeming these rights are left to the special arrangement of each state.

§ 9. Disputes as to whether a particular right is included in those which are declared by §§ 7 and 8 to be abrogated, are to be determined by legal process. It is reserved, however, to the laws of the state to settle by what authorities and by what procedure the question is to be decided, as to whether or to what extent a charge upon real property is a land charge, or is paid for the exercise of a trade or industry.

§ 10. Exclusive trade rights, or "Zwang" and "Bann" rights, which have been by law abrogated, or pronounced subject to redemption, can no longer be acquired in future.

No trade rights connected with the possession of real property can be established for the future.

§ 11. The right to carry on an independent trade or industry is irrespective of sex.

Women carrying on a trade or industry on their own account ("selbstständig") can enter independently into legal covenants, and appear before the court on matters connected with their business, whether they are married or not. It is not open to them in business matters connected with the exercise of their trade to invoke the benefits of the laws relating to women "Rechtswohlthaten der Frauen") which exist in particular states of the confederation. The provisions of this clause apply equally, whether women carry on the trade alone or in conjunction with other persons, or whether they carry it on in person or by proxy.

§ 12. The industrial operations of corporate bodies, not belonging to the confederation ("Juristische Personen des Auslandes") are subject to the laws of each particular state.

Existing restrictions respecting the exercise of a trade or industry by persons belonging to the army or to the official classes, are not affected by the present law.

§ 13. Permission to exercise a trade or industry is not to be made conditional in any commune or with respect to any trade or industry upon the possession of the right of citizenship.

A person having set up a trade or industry is bound at the expiration of three years, at the requisition of the communal authorities, to acquire the rights of citizenship if in conformity with the existing communal constitution. In such cases, however, the prescribed or customary burghership's fee is not to be exacted, nor is the person to be required to give his right of citizenship acquired elsewhere.

PART II.—THE EXERCISE OF STATIONARY TRADES OR CALLINGS ("STEHENDER GEWERBEBETRIEB").

I.—*General Requirements.*

§ 14. Any one setting up a stationary trade or industry on his own account must give notice of it at the time to the authorities appointed for the purpose by the law of the country. A similar notice must be given by any person authorized to carry on an itinerant trade or industry ("Gewerbe im Umherziehen"), Part III.

Further, any person acting as agent, or sub-agent, for procuring insurances for personal or real property, fire insurance office, or any person resigning such agency, or from whom it is withdrawn by the insurance office, must give due notice of the same, within eight days, to the proper authorities of his place of residence. Printers and lithographers, booksellers and printsellers, second-hand booksellers, proprietors of circulating libraries and reading-rooms, sellers of printed matter, newspapers and pictures, on opening a business, are bound to notify to the proper authorities of the place where they reside, at latest on the day of opening, where their business premises are situated, and also any subsequent removal.

§ 15. The authorities must acknowledge the receipt of this notice within three days.

The police may prevent a business from being continued, if a special permission was required for commencing it, and if it was begun without such permission being obtained.

A prohibition of this kind may be appealed against.

II.—*Special Authorizations.*

1.—*Industrial Establishments requiring Special Authorization.*

The consent of the proper authorities designated for the purpose by the laws of each state is required in respect to industrial establishments, which, whether on account of the locality in which they are situated, or owing to the nature of the works themselves, are liable to cause considerable injury, danger, or nuisance to the owners or inhabitants of the neighbouring premises, or to the public in general.

These comprise :—

Gunpowder manufactories, manufactories of fireworks, and explosive materials of all sorts, gasworks for the preparation and storage of gas, petroleum refining works, peat-tar, coal-tar, and coal works, when established away from the spot whence the raw material is derived, glass-works, and blacking ovens ("Russhütten"), chalk and lime-kilns, and gypsum furnaces, smelting-houses, roasting ovens, metal foundries, iron works, chemical works of all kinds, bleaching works, varnish boileries, starch manufactories, with the exception of those where potato starch is prepared, starch-syrup boileries, catgut, pasteboard, and felt works for roofing, glue, train-oil, and soap works, works for the preparation of animal hair, bone-burning, drying, boiling, and bleaching works, tallow boileries, slaughter-houses, tanneries, knackers' yards, human and artificial manure works, dams or reservoirs for the use of water-works (§ 23).

The foregoing list may be altered by a decision of the Federal Council, subject to the approval of the Diet in its ensuing session, whenever a presumption of the kind above-mentioned (of danger or nuisance) arises, or when such presumption has ceased to be founded.

§ 17. The application for permission to establish any of the aforesaid works must be accompanied by explanatory drawings and descriptions. Should these be considered sufficiently complete, the project must be brought to the knowledge of the public by a single advertisement in the journal in which the official notifications of the authorities (§ 16) are published, accompanied by a requisition to all those who have objections to urge against it, to submit them within fourteen days. This delay is to date from the day on which the paper publishing the notification is issued, and is to bar all future objections, excepting those based upon the legal rights of individuals.

§ 18. Should no objections be raised, the authorities have to examine whether the establishment of the business in question is one calculated to cause any considerable risk, injury, or nuisance to the public. According to the result of this examination, which must extend to the due observance of the police, fire, building, and sanitary regulations, the permission is either to be refused or granted under such conditions as may be proved to be necessary. These latter include regulations for protecting the health and lives of the workmen. The decision must be given in writing, and must state the conditions which have been laid down, and must be accompanied by the reasons for refusing a permission, or for granting it under certain conditions only.

§ 19. Objections founded on special private rights must be decided upon by the courts of law ; but the grant of a license is not to be dependent upon these objections having been disposed of.

Other objections, on the other hand, must be fully discussed in the presence of the parties ; after which, the matter is to be examined into, and the decision given in the manner prescribed by § 18. This decision is to be communicated both to the promoter and to the opponent of the undertaking.

§ 20. An appeal lies from this decision to the superior authority next in rank, which must be defended, however, within fourteen days from the date of the publication of the decision, or the appellant loses his right.

The judgment on the appeal is to be communicated to both parties in writing, accompanied by the reasons on which it is founded.

§ 21. It is reserved to the laws of each state to appoint the authorities, and to prescribe the mode of procedure both in the first instance and in the appeal. The following principles, however, are to be adhered to:—

1. Either the authority deciding in the first instance, or the authority deciding upon the appeal, must be a board ("eine Kollegiale Behörde"). This authority is empowered to institute inquiries on the spot, to call witnesses and experts, and to take evidence on oath, and investigate the matter thoroughly.

2. If the authority, in the first instance, is represented by a board, its decision must be given in an open sitting, after having summoned and heard the parties, even though no objections have been raised to the application, when it refuses to grant the permission without further inquiry, and when the promoter, within fourteen days after the receipt of the decision, refusing his application, or granting it only under conditions, proposes that the matter shall be discussed orally.

3. If the board acts as the court of appeal ("Zweite Instanz"), its decision must be pronounced in an open sitting, after having summoned and heard the parties.

4. The promoters of the undertaking, and the persons raising objections to it, are to be considered as parties.

§ 22. Costs originating in groundless objections fall upon the opponents of the scheme; all other costs arising out of the proceedings are to be defrayed by the promoter.

The division of costs must be settled at the same time that a decision is given in respect to permitting the proposed works.

§ 23. Reservoirs ("Stand Anlagen") for the use of waterworks, in addition to the rules laid down in §§ 17 to 22 are subject also to the regulations prescribed for the purpose by the laws of each particular state.

Each state has the right reserved to it of prohibiting by legislation the further use of existing or the establishment of new private slaughter-houses in places where public slaughter-houses in sufficient number already exist or are about to be erected.

Each state has, moreover, the right reserved to it of prescribing by legislation to what extent local statutes ("Orts-Statuten") are authorized to decide that certain districts are to be fixed upon in preference to others for erecting works of the kind specified in § 16, whereas in other districts such establishments are to be prohibited altogether, or only allowed under special restrictions.

§ 24. The permission of the competent authorities according to the laws of each state is required for the erection of steam-boilers, whether intended to work machinery or not. The application for permission must be accompanied by explanatory drawings and descriptions.

The authorities have to examine whether the proposed works are unobjectionable as regards the police, building, fire, and sanitary regulations, and also as regards the general police directions issued by the Federal Council in respect to the erection of steam-boilers. They have, according to the result of the inquiry, either to refuse permission or to grant it unconditionally, or in granting it, to prescribe such precautions and arrangements as may be necessary.

The regulations existing in each state of the confederation are binding until general directions have been issued on the subject by the Federal Council.

Boilers must be examined before use to see if the regulations enjoined by the license have been complied with. Anyone beginning to use a boiler without having received the certificate which is to be issued on the occasion, incurs the fine imposed by § 147.

The foregoing rules apply also to movable boilers.

The rules laid down in § § 20 to 21 apply to appeals on this subject and the proceedings connected with them.

§ 25. The permission to set up any of the works specified in § § 16 and 24 is valid as long as there is no change in the site or character of the premises, and, subject to this condition, it requires no renewal even if the business passes into other hands. If any change, however, is made in the works, the permission of the competent authorities is required as prescribed in § § 17 to 23, inclusive, and, under certain circumstances, in § 24. A similar permission is necessary when any important change is introduced into the business carried on at any of the works specified in § 16. The competent authority may dispense, however, on the proposition of the owner of the works, with advertising the contemplated change (§ 17) if convinced that it is not calculated to produce any new or greater injury, risk, or nuisance to the owners or inhabitants of the neighbouring premises than the actual works.

These provisions extend also to industrial establishments (§ § 16 to 24) which have existed prior to the passing of the present act.

§ 26. In cases where existing laws enable the owner or possessor of a property ("Grundstück") to bring a private action ("Privatklage") to protect it against injurious effects occasioned by an adjoining property, the action cannot, under any circumstances, be directed to stopping the works as regards any industrial establishment which has been set up with the sanction of the authorities, but only to insure arrangements being made to obviate the injurious effects, or, if such arrangements are incompatible with carrying on the works, to indemnification.

§ 27. The erection or removal to another place of works which cannot be carried on without more than ordinary noise, if not requiring the permission prescribed in § § 16 to 25, must be notified to the local police authorities. When churches, schools, or other public buildings, hospitals or "maisons de santé" exist in the neighbourhood of the proposed works, and would be likely to suffer seriously in their prescribed uses by the business being carried on in that particular spot, the local police authorities must refer to their superior administrative authorities to decide whether the permission to carry on the works on the proposed site is to be refused, or only to be granted conditionally.

§ 28. The superior administrative authorities are empowered to issue police directions with respect to the distance from neighbouring premises and from public roads at which machinery driven by wind is to be erected.

2.—Trades or Professions requiring Special Authorization.

§ 29. Apothecaries and all persons styling themselves doctors (surgeons, oculists, accoucheurs, dentists, and veterinary surgeons), or by similar titles, or who are recognized as such by the state or a commune, or are charged with official duties, require an authorization, which is given to them on proof of competency. This authorization, however, is not to be conditional on the applicant having previously received an academical degree of doctor.

The Federal authority is to determine, with reference to existing wants, what authorities in different parts of the Federal territory are to be charged with issuing authorizations which are to be valid throughout the whole confederation, and is to issue directions as to the required proof of competency on the part of the recipient. The names of those persons to whom authorization has been granted must be published by the authorities granting it in the official journal fixed upon by the Federal Council.

Persons having received such authorization are not restricted, within the limits of the confederation, in the choice of the place where they choose to exercise their professional calling, subject to the rules laid down in § 6 with regard to the establishment or removal of apothecaries' shops.

A right is reserved to the Federal Council of determining upon what presumption ("Voraussetzungen") persons are to be exceptionally relieved from the prescribed examination on account of proved scientific attainments.

Persons who, previous to the promulgation of this act, have already been entitled to pursue their calling in a federal state as doctors, surgeons, dentists, accoucheurs, apothecaries, or veterinary surgeons, are to be considered as authorized throughout the whole territory of the confederation.

§ 30. A license from the superior administrative authorities is required for the establishment of private hospitals, private lying-in hospitals, and private asylums, which is to be granted when there is no reason for withholding it on the ground of the applicant not being a proper person to conduct the proposed undertaking.

Midwives require a certificate of having passed an examination from the authorities appointed for the purpose by the law of each state.

§ 31. Masters of ships, mates, and pilots, have to prove that they possess the requisite knowledge by obtaining a certificate of qualification from the proper administrative authorities.

The Federal Council issues the instructions which are to be followed with respect to furnishing proof of qualification. The certificates given on production of this proof are valid for the whole confederation, but in the case of pilots, only for the navigable waters specified in the certificate.

Special regulations, made in pursuance of treaties in regard to masters and pilots in rivers, remain in force.

§ 32. Theatrical managers require a permission to exercise their calling, which is to be granted when there is nothing to prove that the applicant is unfit to carry on the business.

No restriction to any particular class of theatrical representations is allowed.

§ 33. Hotel-keepers, publicans, and retail dealers in brandy or spirits require a permission to enable them to exercise their trade.

This permission can only be refused in the following cases:—

1. When there are circumstances justifying the assumption

that the applicant will misuse the business to promote drunkenness, illicit play, the receiving of stolen property, or immorality.

2. When the premises in which it is intended to carry on the business are not such as to satisfy the requirements of the police, whether as regards their condition or situation.

The Government, however, has a right, when not at variance with the law of the country, of making the permission to open brandy-shops, and to retail brandy and spirits, conditional on its being proved that they are necessary.

§ 34. The law of each state has power to direct that a special authorization shall be required for the sale of poisons, and for the exercise of the profession of pilot; also, that only those persons shall be permitted to act as surveyors of mines ("Markscheider") who have qualified themselves, and have been licensed as such.

§ 35. Persons undergoing penalties for offences or crimes against morality are prohibited from giving lessons, professionally, in dancing, gymnastics, and swimming.

Any person who has been punished for an offence or crime against property, committed from motives of gain, may be prohibited from trading in second-hand clothes, bedding, or linen, from selling in retail old ironware or broken metals, yarn, refuse, or shreds of silk, wool, cotton, or linen, as also from exercising the trade of pawnbroker.

Any person who has been punished for an offence or crime against property, committed from motives of gain, or for an offence or crime against morality, may be prohibited from carrying on the business of an agency for the hire of servants.

Persons setting up any of the trades specified in this clause are bound to notify the opening of their business to the proper authorities.

§ 36. Land surveyors, auctioneers, persons whose business it is to decide upon the degree of purity of the precious metals, or upon the quality, bulk, or proper packing of goods of any kind, agents, weighers, measurers, sorters, inspectors, stowers, &c. may follow their occupation without restriction, but the state or communal authorities constitutionally authorized to deal with the matter have a right to swear such persons to the due observance of existing regulations, and to install them publicly.

Those legal provisions which attach peculiar trustworthiness to the proceedings of persons pursuing any of the above-mentioned callings, or which invest their proceedings with any special legal force, are applicable only to persons who have been installed by the state or communal authorities, or by corporations constitutionally authorized to do so.

§ 37. The regulation of the public traffic in carriages of all kinds, gondolas, sedan-chairs, horses, and other modes of transport, is placed within each district under the administration of the local police authorities, as is also the trade of persons offering their services for hire in the public streets or squares.

§ 38. The central authorities are empowered to issue directions as to the manner in which persons engaged in any of the trades specified in § 35 (second and third paragraphs) are to keep their books, and to what amount of police control they are to be subject as regards the extent of and mode of conducting their business.

§ 39. The laws of each state may authorize the establishment of circuits for chimney-sweepers, but where these circuits exist or may be established the superior administrative authority has the power, with due respect for private rights, of either abolishing or altering them, without any right of opposition or claim to indemnity on the past circuit chimney-sweeper.

§ 40. The approvals and authorizations mentioned in § § 29 to 34 are not to be given for any definite period; nor, subject to the rules laid down in § § 53 and 143, can they be revoked.

An appeal is allowed against the refusal to grant permission to exercise any of the trades or avocations specified in § § 30, 32, 33, and 34, as also against prohibitions to carry on trades, &c. specified in § § 35 and 37. The mode of procedure and the authorities in cases of this kind are such as prescribed in § § 20 and 21.

III.—*Extent, Exercise, and Loss of Industrial Rights.*

§ 41. The right possessed by a person of carrying on a stationary industry on his own account includes also the right of taking any number of journeymen, assistants, and workmen of all kinds; and, in so far as this law does not otherwise provide, any number of apprentices.

The right of apothecaries to take in assistants and apprentices is to be regulated by the law of each country.

§ 42. Any person entitled to carry on a stationary industry may exercise it, subject to the provisions of § 59, both in the place where he has established it, and also, unless the rules prescribed in Part III. oblige him to have a warrant ("Legitimationsschein"), beyond its limits.

§ 43. Any person desiring, as a matter of trade, to cry, sell, or distribute, fix or post up, printed papers or pictorial representations, in the public thoroughfares, streets, squares, or other public places, must obtain permission from the local police authorities to enable him to do so, and in applying for permission he must bring with him his "Legitimationsschein," with his name on it.

This permission can only be refused under the conditions of, and in accordance with, § 57.

§ 44. Tradesmen, manufacturers, and others carrying on a stationary industry, have a right, either personally or by means of travellers in their employ, to buy up goods and take orders for goods elsewhere than at the place where they have established their trade.

They require for this purpose a warranty ("Legitimationsschein") to be delivered to them by the subordinate police authorities, and valid for the current year.

The "Legitimationsschein" is not necessary when the trader has been privileged for the whole territory of the confederation by obtaining the "license to trade" ("Gewerbe-Legitimationskarte") prescribed by the Zollverein treaties.

The possessor of such a "Legitimationsschein" is only allowed to carry about with him for conveyance to their destination goods which he has bought up on speculation, and only the samples and patterns of goods for which he is endeavouring to procure orders.

§ 45. The right of carrying on a stationary industry may be exercised by deputy, but the deputy must satisfy the requirements specially belonging to the industry in question.

§ 46. On the decease of any one carrying on an industry, it must be continued on account of the widow during her widowhood, or, in case of there being heirs under age, on their behalf by a representative qualified in the manner enjoined by § 45, in so far as special rules applying to the exercise of particular trades do not prescribe otherwise. This rule applies during the period of a guardianship, or during the settlement of an inheritance.

§ 47. In what measure persons who have been licensed or appointed in conformity with §§ 34 and 36 are to be allowed to act by deputy, must be decided in each particular case by the authorities whose business it is to confer the license or appointment.

The same rule applies to chimney-sweepers to whom a circuit has been assigned.

§ 48. Trade monopolies attached to the possession of real property ("Real-Gewerbeberechtigungen") can be transferred to anyone if qualified, in the manner prescribed by the present law, to exercise a trade, provided that the acquirer of the trade monopoly exercises it on his account.

§ 49. In granting licenses to any of the establishments specified in §§ 16 and 24, also to private hospitals, private lying-in hospitals, and private asylums, and theatrical entertainments, and licenses to carry on any of the trades mentioned in § 33, the licensing authorities have power, according to circumstances, of fixing a certain interval of time within which the establishment or undertaking must be begun and completed and the business commenced, under pain of the license expiring. Should no such term be fixed, the license is to expire if the holder of it allows a whole year to elapse after its receipt without having made use of it.

This delay may be prolonged by the authorities when there are no serious objections in the way.

When the holder of a license of this kind has stopped his business for a period of three years without having applied for and obtained a postponement, the license expires.

As regards the establishments specified in § 16, the delay must be accorded so long as there is any uncertainty as to the ownership of them either on account of succession or bankruptcy, or as long as the business, from causes beyond control, cannot be carried on at all, or only at a serious loss to the owner.

The mode of procedure in respect to granting delays is similar to that for licensing new establishments.

§ 50. The delays mentioned in § 49 apply also to holders of licenses granted prior to the publication of this law, but with the proviso that the delays are to date from the day on which the law is promulgated.

§ 51. The chief administrative authorities have at all times power to close any industrial establishment on the ground of serious injury and danger to the public. In this case, however, compensation must be given to the owner for loss which he can prove to have incurred.

The order to close an establishment may be appealed against. On the question of compensation the courts of law may be appealed to.

§ 52. The provision of § 50 applies also to industrial establishments already existing at the time of the promulgation of the present law; but an order to close certain works cannot give rise to any claim to indemnity if the license originally granted con-

tained an express stipulation that it should be revocable without indemnity.

§ 53. The authorizations ("Approbationen") specified in § 29 can only be revoked by the administrative authorities when the information upon which it was granted is proved to be incorrect.

On the same grounds the licenses and appointments mentioned in §§ 30, 32, 33, 34, and 36, may also be similarly revoked when the acts of or non-observance of his duties by the holder clearly show that he is wanting in those qualities the possession of which must have been assumed, in accordance with the present law, before granting the license or appointment.

Whether the person has incurred a fine for such acts or non-observance of his duties is a question reserved for judicial decision.

§ 54. The regulations contained in § 20 and 21 are applicable in regard to the mode of procedure and to determining what authorities are competent in the matter of closing industrial establishments (§ 51), of preventing a business from being carried on (§ 15, 2, and § 35), and of revoking an authorization or appointment (§ 53).

Part III.—The Exercise of Itinerant Trades.

§ 55. Anyone who, away from his place of residence, without establishing a permanent place of business, and without receiving a previous order for goods,—1, personally offers goods of any kind for sale; 2, buys up goods of any kind for resale from others than traders, or elsewhere than in public places of sale; 3, applies for orders for goods; or, 4, offers his professional or artistic services for money, or exhibits shows which have no predominating scientific or artistic interest, must be provided with a "Legitimationsschein," subject to the regulations prescribed in §§ 44 and 64.

A "Legitimationsschein" is not required for selling or buying raw produce of agriculture, of forests, gardens, and orchards.

§ 56. The following articles are not allowed to be purchased or sold by itinerant traders:—

1. Spirituous liquors of all kinds.
2. Second-hand clothes and bedding, yarn refuse, ends and shreds of silk, wool, linen, or cotton, gold or silver broken up.
3. Playing cards, lottery tickets, public securities (shares or papers) representing value of any kind.
4. Gunpowder, fireworks, and other explosive substances.
5. Medicines, poisons, and poisonous substances.

The Federal Council, should it be necessary, has the right of ordering permission to be granted for the sale or purchase of any of the excluded articles.

The Federal Council, and in urgent cases the Federal Chancellor, in concert with the committee of the Federal Council, has the right on grounds of public security, or for sanitary reasons, to forbid for a specific term other articles besides the above from being offered for sale or purchased by itinerant traders.

§ 57. A "Legitimationsschein," subject to the provisions of § 54, cannot be refused to anyone belonging to the North German Confederation who has a fixed domicile within its territory, and who has completed his 21st year, unless,—1, he is affected with an offensive or contagious malady; 2, or has been sentenced to not less than six weeks' imprisonment, or to a minor punishment if coupled with a partial deprivation of the exercise of civil rights, for crimes against property committed from motives of gain, and against morality, for deliberate assaults with intent to kill or injure, for wilful incendiarism, for acting in disregard of prohibitions or measures of precaution adopted to prevent the introduction or spread of contagious diseases or of the cattle plague. The "Legitimationsschein" in these cases to be withheld for two months from the date of the sentence, and in case of imprisonment, until the term of imprisonment has been undergone; 3, or is under the supervision of the police; 4, or has a bad reputation for habitual aversion to work, for begging, vagrancy, or addiction to drunkenness. The authorities must either furnish the applicant with a "Legitimationsschein" or refuse it in writing, stating the legal grounds which prevent it being granted. The mode of procedure and the authorities are the same as prescribed in §§ 20 and 21.

Foreigners may be allowed to exercise an itinerant trade. The Federal Council is empowered to frame the necessary measures relating thereto.

§ 58. A "Legitimationsschein" is to be given—

1. For the sale and purchase of game and fish.
2. For the sale of goods manufactured by the salesman, and which belong to the class of articles with which the weekly market is supplied; also for tendering industrial services according to the established usage of the country, within certain limits of the place of residence to be specified by the police authorities, by the competent subordinate authority of the place where the trader is domiciled; and for every other class of itinerant trade by the chief administrative authorities.

In those cases in which the law renders the exhibition of a trading license ("Gewerbeschein") obligatory, the latter may be substituted for the "Legitimationsschein."

§ 59. Anyone giving musical performances in public, exhibiting shows, giving theatrical representations, or other public entertainments, which have no superior interest on the score of science or art, in the public streets, or in moving from place to place, or only staying at a place *en passant*, without establishing a permanent business, requires the previous permission of the authorities of the place where it is proposed to give the performances, in addition to the other requirements with which he is called upon to comply.

No further "Legitimationsschein" are to be issued for industries of the nature described, when a sufficient number in relation to the wants of the administrative district has already been issued.

Wandering theatrical companies can only receive a "Legitimationsschein" on condition that the manager is provided with the license prescribed in § 32.

§ 60. The "Legitimationsschein" must contain a personal description of the holder and a specification of the nature of the industry in which he wishes to engage. It is valid only for the current year, but as long as the conditions prescribed by § 57 are complied with its renewal may be claimed as a matter of right.

The possession of a "Legitimationsschein" for carrying on the industries specified in § 59 confers the right of carrying them on in a district other than that of the chief administrative authority who issued it, only on condition of its being extended to the other district by the chief administrative authority of the latter. This extension is not to be granted whenever "Legitimationsscheine" have been already given or extended in sufficient numbers to supply the wants of the district.

§ 61. The owner of a "Legitimationsschein" is bound to carry it about with him whilst actually engaged in his industrial occupations, to produce it on the demand of the proper authority; or, if he is unable to produce it, to stop when ordered to do so by the authority until the deficiency has been supplied.

§ 62. An itinerant industry cannot be exercised by deputy. An exception to this rule is made as regards the sale of articles specified in § 58, within such limits of the place of residence as may be defined by the police authorities, and also as regards the industry specified in section 2 of § 58.

The attendance of other persons, whether for the conveyance of the goods, for looking after the horses, or for any other purpose, must be expressly sanctioned in the "Legitimationsschein" by the authorities issuing it, or in whose district the applicant happens to be. This permission can only be refused on the grounds and in the manner set forth in § 57 for refusing "Legitimationsschein" to the promoter of the business. This permission is never to be granted to children under 14 years of age.

§ 63. Power is reserved to the legislation of each confederate state to eliminate from the restrictive clauses of this part, as far as its territory extends, the itinerant sale or purchase of certain specified articles of general use.

Part IV.—Market Trade.

§ 64. Every one has an equal right to attend fairs and yearly and weekly markets, and to sell and purchase at them.

Where, however, according to previous local custom, only the inhabitants of a place where a market is held have been allowed to sell at the weekly markets certain hand-made goods not included in the articles specified in § 66, the chief administrative authorities may, on the proposal of the communal authorities, authorize resident salesmen to continue the usual market trade in such hand-made goods, without according a similar right of sale at the weekly markets to strangers.

Power is reserved to the Federal Council of imposing retaliatory restrictions upon foreigners as regards trading at markets, when restrictions are imposed abroad upon subjects of the confederation.

§ 65. The number, time, and duration of the fairs, and of the yearly and weekly markets, are to be settled by the competent administrative authorities.

No opposition can be raised against any such ordinance by those who are entitled to hold the market; no claim to compensation can be preferred unless the number of markets hitherto held is reduced by the ordinance, and a greater number was expressly and irrevocably fixed by the grant. Communes desirous of making good a claim to compensation must prove that their right rests upon a special prescriptive privilege.

§ 66. The following are the articles permitted to be sold at weekly markets:—

1. Raw natural productions, with the exception of cattle.

2. Manufactures, the production of which is closely connected with agriculture and the management of forests, with the cultivation of gardens and orchards, and with fisheries, or which are the produce of the labour of the country people of the neighbourhood out of their working hours, or of labourers' work, with the exception of spirituous liquors.

3. Fresh provisions of all kinds. The competent administrative authorities have the power of deciding what additional articles, according to the usages of the place and the wants of the district generally, or of certain localities, are to be included for sale at the weekly markets.

§ 67. At the annual markets, in addition to the objects specified in § 66, articles of consumption and manufactures of all kinds may be offered for sale.

The permission of the local police, however, is necessary for the sale of spirituous liquors for consumption on the premises.

§ 68. In no instance is the market trade to be charged with any other dues than those levied as compensation for the space occupied, and for the use of stalls and market gear. No alteration is made by the present law in existing rules as to whether or to what extent dues of this kind are to be levied at all. No distinction is allowed, with reference to the payment of dues, between natives and strangers.

§ 69. The local police authorities, in conjunction with the communal authorities, have the power, within the limits of the provisions of § 65 to § 68, of establishing market regulations according to local requirements, particularly of assigning the place where articles of the same kind are to be offered for sale, and of fixing what goods, whether cried or not, are to be sold by itinerant vendors, and at what time of day.

§ 70. Markets which are held on special occasions, or for the sale of particular kinds of commodities, are to be subject to the regulations at present in force.

The trade of these markets may be extended by the competent authorities with the consent of the authorities of the commune.

§ 71. All restrictions upon the sale of articles brought to fairs and markets and not sold, are abolished herewith. The separate sale of such articles out of market hours is only permitted, however, under the same conditions of sale as would be allowed if they had not been brought to market.

Part V.—Regulation Charges ("Taxen").

§ 72. No regulation charges fixed by the police are to be established in future, except as hereinafter directed.

Existing regulation charges are to be abolished within a certain period, to be fixed by the local police authorities, which is not to exceed a year at the utmost.

§ 73. Bakers, and sellers of breadstuffs, may be compelled by the local police authorities to acquaint the public with the prices and weights of their different sorts of bread, by posting up a notice in a conspicuous part of their premises, for such time as the authorities may prescribe.

This placard must be stamped by the police, free of cost, and hung up daily during the hours of sale.

§ 74. Bakers and salesmen, when they are only allowed to sell their bread and breadstuffs at the prices posted up in their shops, may also be obliged by the local police authorities to put up scales in their shops, with the necessary standard weights, and to allow them to be used for reweighing bread which has been bought.

§ 75. Innkeepers may be compelled by the local police authorities to hand in a list of the prices fixed by them, and to post it up in the rooms frequented by visitors. These prices may be altered at any time, but they remain in force until the change has been notified to the police authorities, and the amended list has been posted up in the rooms. The police authorities may decide provisionally, under reserve of legal proceedings, upon complaints made by travellers of overcharges.

§ 76. The local police authorities, in conjunction with the authorities of the commune, have the right of fixing regulation charges for valets de place, and others, who offer their services in the public streets and squares, or at hotels (§ 37); also for the use of carriages, horses, sedan-chairs, boats, and other means of conveyance established for the service of the public.

§ 77. The local police authorities can also, in conjunction with the authorities of the commune, establish regulation charges for chimney-sweepers, when a district has been exclusively assigned to them, or the subordinate administrative authorities may fix regulation charges when the district assigned includes more than one locality.

§ 78. The present law makes no change with respect to regulation charges in the case of persons carrying on an industry, who have to be sworn and installed by the authorities, as stipulated in § 36. The authorities pointed out in § 36 are empowered to introduce regulation charges for such persons where they do not already exist.

§ 79. Persons engaged in any of the industries mentioned in § 73 to § 78 have the right of reducing the regulation prices and charges.

§ 80. The scale of charges for apothecaries may be fixed by the central authorities; but these prices may be lowered by free consent.

The payment of authorized doctors, &c. (§ 29), is left to private arrangement.

In the absence of any arrangement, and as a guide in disputed cases, regulation charges may be fixed by the central authorities.

Part VI.—Trade Corporations (Guilds, &c.).

1.—*Existing Corporations.*

§ 81. All trade corporations (companies, guilds, &c.) legally existing at the present time may continue to do so. Their statutes (guild articles, &c.) are to remain in force in so far as they are not changed by the provisions of the present law or affected by the stipulations of § 92.

§ 82. Every member of a guild has a right at any time, subject to the discharge of his obligations, of retiring, and of continuing the same trade after his withdrawal. A member withdrawing from a guild loses all claim to the property of the guild, and to collateral funds either wholly or partially founded by it, unless the statutes of the guild prescribe differently.

§ 83. The following persons may be prevented from entering a guild:—

1. Those who have been deprived of their civil rights.

2. Those who are temporarily deprived of the exercise of their civil rights.

3. Bankrupts.

§ 84. Subject to the foregoing provision (§ 83), no one can be refused admittance to a guild who has fulfilled the conditions prescribed by the statutes.

If an examination is necessary for admittance to a guild, the examination must be directed to prove that the person is qualified to carry on the ordinary work of his trade on his own account.

The expenses of admittance into a guild, as also the sum required to cover the cost of the examination by the person undergoing it, are to be settled by the guild. No preference must be shown.

Certificates of having passed the examination given by the special examiners appointed for particular trades, or by commissions hitherto qualified to examine, are to be considered as sufficient proof of capacity to carry on the trade in respect of which the certificate was issued.

No one who has worked on his own account at a trade for one year at least can be called upon to furnish a proof of his qualification.

§ 85. The entrance money to be paid on admission into a guild must be the same for all the members. When it amounts to more than 5 dollars (15*s.*) it cannot be raised without the sanction of the superior administrative authorities. This sanction is also required when the entrance money does not exceed 5 dollars, and is to be raised about that amount. Joining a guild does not preclude a person from being a member of other guilds.

§ 86. By a decision of the guild, anyone under the circumstances mentioned in § 83, Nos. 1, 2, and 3, may be debarred from the exercise of his vote, and also deprived of his honourable rights in the guild.

§ 87. When the trade of a deceased member of the guild is continued by a representative for the benefit of the widow, or of heirs under age, the right and obligations of the deceased member, with the exception of the right of voting at the guild meetings, are transferred to the widow for the term of her widowhood, or to the heirs under age during their minority.

§ 88. The guild is represented in all judicial and extra-judicial proceedings by its presiding board ("Vorstand").

The legal qualification of the latter to act as such must be certified by the communal authorities.

Its representative jurisdiction extends to all affairs and legal proceedings, for which a special power of attorney is required by law.

Where the statutes ("articles of the company," or "articles of the guild") delegate to one or more members of the presiding board the office of representing the guild in public ("nach aussen"), the *status quo* is maintained.

§ 89. Contracts made by the guild for the acquisition, sale, or mortgage of real property, and for loans for a longer period than one year, secured upon the real property of the guild, or upon its revenues, require the sanction of the communal authorities.

§ 90. Payments to members of the guild out of its receipts or

property are allowed only when they are in accordance with the express provisions of the guild statutes. Payments of this nature are never to be made to defray expenses of living.

§ 91. The payment of contributions to the guild, or of fines incurred by members of the guild for breaches of the statutory regulations, is no longer to be enforced by the intervention of the state.

§ 92. The statutes may be altered by an absolute majority of those present at a meeting of the guild, to which the whole of the members entitled to vote have received a written invitation, distinctly setting forth the proposed subject of deliberation. This decision must be ratified by the superior administrative authority when it deals with payments out of the receipts or property of the guild to members, or otherwise disposes of property belonging to the guild. The authorities cannot refuse to give their consent, if it is shown that full security remains for the discharge of all the existing obligations of the guild, and, in case of dissolution, for the observance of the regulations prescribed by § 94.

§ 93. A guild has the power of dissolving itself by the vote of an absolute majority of those present, at a meeting to which all members entitled to vote have received a written invitation distinctly stating the proposed subject of deliberation. This decision requires the sanction of the superior administrative authorities. The sanction must be given if the debts have been discharged and due security given for the observance of the regulations prescribed in § 94.

§ 94. On the dissolution of a guild its property must be applied in the first instance to the settlement of its debts and to the discharge of any other obligations which it may have. If the property was applied up to that time, either wholly or in part, to the foundation of schools or to other public purposes, it must still continue to be so applied. If this object is not sufficiently carried out by other means, the property in question is to revert to the commune, upon the latter undertaking all the charges upon it.

The right of a guild on its dissolution to divide the net residue of its property amongst its actual members extends only to property arising from the contributions of those members. The remainder of the property, unless otherwise expressly enacted by the statutes or by the laws of the state, must be handed over to the commune in which the guild had its seat, to be used for industrial purposes.

In case of any disputes, arising out of the preceding provisions, between the commune and guild, a power of arbitration rests with the superior administrative authorities.

The latter are also empowered, on the dissolution of a guild, to confer corporate rights upon schools, aid funds ("Hülfskassen"), and other institutions established for public objects which have been in connection with the guild.

The preceding rules are applicable also in case of the extinction of a guild by the death of all its members.

§ 95. The communal authorities exercise a supervision over guilds. They have to decide disputes about the reception and exclusion of members, the election of the presiding board, and the rights and duties of the latter. An appeal lies against their decision to the superior administrative authority; but the appeal must be lodged with the communal authorities within four weeks, or the right of appeal is forfeited.

Meetings of a guild held for the purpose of altering the statutes, or of dissolving the guild, must be attended by the communal authorities, represented by one of them, or by some one commissioner appointed by them for the purpose. They take no part in any other deliberations of the guild, and henceforth they have nothing to do with ratifying the election of the presiding board.

§ 96. All provisions of the laws or of the guild statutes which confer greater powers upon the communal authorities in matters of the guilds than are conferred by the present law are hereby repealed.

2.—*New Guilds.*

§ 97. All persons carrying on similar or kindred trades may join in forming a guild.

New guilds acquire the rights of corporation as soon as their statutes have been confirmed.

§ 98. The objects of new guilds must be to advance the common interests of their trades.

§ 99. The statutes of the guild must be approved by the superior administrative authorities.

§ 100. The statutes must determine the conditions upon which members are to be received into the guild, the rights and duties of members, the scale upon which the associates of the guild are to be charged for current contributions, and the particular consequences resulting from neglect to pay them, the composition of the presiding board, and also the arrangements for administering the common affairs of the guild.

§ 101. Every guild must have a presiding board ("Vorstand"), the members of which are to be elected by the associates of the guild.

§ 102. The amount and application of the contributions, and the administration of the finances and accounts, are to be regulated by resolutions passed by the guild.

§ 103. The provisions of §§ 82 to 96 are applicable also to new guilds.

§ 104. Corporations of merchants, in which no exclusive trade privileges have been vested, are not subject to the rules laid down in this section (Part VI.).

Part VII.—Assistant Workmen, Journeymen, Apprentices, Factory Operatives.

I.—*Position of Journeymen, Assistant Workmen, and Apprentices.*

1.—*General Provisions.*

§ 105. The relations to be established between persons exercising a trade on their own account and their journeymen, assistants, and apprentices, are matter for mutual arrangement between the parties.

Nobody is bound to work on Sundays and holidays, unless an agreement has been made to do so in cases of urgency.

§ 106. It is the duty of the authorities designated for the purpose by the laws of each state to insure that, where apprentices are employed, due regard is paid to their health and morals, and that those apprentices who still require religious and school instruction are allowed time for the purpose.

Journeymen, assistants, and apprentices, until they have completed their eighteenth year, or particular classes of them, can be compelled by local statute ("Ortsstatut") or bye-law of a commune (§ 142), to frequent a local school to complete their education ("Fortbildungsschule"), and employers and masters are bound to afford them the necessary time for attending it.

§ 107. Every person setting up a trade is bound at his own cost to make and maintain such arrangements with reference to the special nature of the trade, and of the premises in which it is carried on, as are necessary to secure the workmen as far as possible from danger to life and health.

§ 108. Disputes between masters and their journeymen, assistants, and apprentices, with reference to the commencement, continuation, or cessation of their labour engagements or apprenticeship, or as to what the parties are reciprocally bound to do whilst the engagement lasts, or in respect of the certificates mentioned in §§ 113 and 114, whether they are to be given, or what they are to contain, are to be referred for settlement to the special authorities, if any, constituted for that purpose, or, when no such authorities exist, to the authorities of the commune.

The parties interested may appeal from the decision of the communal authorities to the courts of law within ten days, after which time the right lapses, but the decision must be provisionally carried out at once.

A power of deciding such cases may be vested by local statute (§ 142) in courts of arbitration ("Schiedsgerichte") in place of the authorities at present designated for the purpose. They must be organized by the communal authorities, and must be composed equally of employers and workmen.

2.—*Special Provisions.*

(*a*).—*Journeymen and Assistants.*

§ 109. Journeymen and assistant workmen are bound to comply with the regulations made by their employers in respect to the work assigned to them and to domestic arrangements, but they are not obliged to do any household work.

§ 110. The relations between employers and their journeymen and assistant workmen may be terminated reciprocally, unless a contrary agreement has been made, by giving fourteen days' previous notice to that effect.

§ 111. Journeymen and assistant workmen can be dismissed before the expiration of their contract, and without previous notice:—

(1.) If they are guilty of theft or embezzlement, or if they lead a dissolute life.

(2.) If they persistently refuse to discharge the duties imposed upon them by their contract.

(3.) If, in spite of warnings, they are careless in the use of fire and lights.

(4.) If they commit acts of violence, or are guilty of gross insults towards their employer or the members of his family.

(5.) If they hold suspicious intercourse with members of the family of the employer, or seduce their fellow-workmen to do things which are contrary to law or good morals.

(6.) If they are incapable of continuing their work, or if they are affected with an offensive disease.

The terms of the contract, and the general provisions of the laws, are to determine whether, in any of the six above-mentioned cases, the person dismissed is entitled to compensation.

§ 112. Journeymen and assistant workmen may quit their employment before the expiration of their contract, and without previous notice :—

(1.) If they are incapacitated for work.

(2.) If the employer is guilty of acts of violence or gross insult towards them or members of their families.

(3.) If the employer, or members of his family, endeavour to seduce them, or members of their families, to do anything contrary to law or good morals.

(4.) If the employer does not pay the wages which are due in the manner agreed upon ; or, when the journeymen and assistants are paid by piecework, does not give them sufficient employment, or takes illegal advantage of them.

(5.) If, by continuing to work, they would expose their lives or health to evident risk, which was not apparent at the time when they agreed to the contract.

§ 113. Journeymen and assistants, on leaving, are entitled to a certificate stating the nature and length of their employment, which the communal authorities must attest and stamp gratis if the parties concerned desire it, and if there is nothing to object to in what the certificate contains. If journeymen and assistants require it, the certificate must also mention their conduct.

The legal obligation to carry about labour-books ("livrets") is abolished.

§ 114. Journeymen and assistants are unrestricted in the choice of their masters or employers.

There is no obligation to travel about. Travelling journeymen and assistants have no claim for assistance from their associates in the trade.

(*b.*)—*Apprentices.*

§ 115. Any one is to be considered as an apprentice who works under a master for the purpose of learning a trade, whether he pays a premium for learning it or gives his labour gratuitously, or whether he receives wages for his labour.

The provisions of § 106, 116, 117, and 119 are not applicable to apprentices over 18 years of age.

§ 116. Persons who have been deprived, for other than political crimes and offences, of the full enjoyment of their civil rights, or who have been legally condemned for theft or fraud, are excluded during the period of their deprivation, unless they have been reinstated, from the right of keeping apprentices.

§ 117. No one exercising a trade, and who is debarred from the right of keeping apprentices, is allowed to keep on those whom he had previously taken.

§ 118. The master must take care to train the apprentice to become an efficient journeyman by employing and instructing him. He is not to deprive the apprentice of the necessary time and opportunity for becoming so by employing him in other services. He must endeavour to train the apprentice to industrious and good habits, and to keep him from vice and debauchery.

§ 119. The apprentice is placed under the paternal discipline of the master, and in the absence of the latter is bound to obey the journeyman or assistant who represents him.

§ 120. An apprenticeship may be terminated by the master before its expiration in the cases specified in § 111. In the absence of any special agreement relative to such a contingency, the apprentice's premium ("Lehrgeld") is invariably to be paid for the term which has elapsed. If the apprentice is dismissed for any of the first five causes specified in § 111 the master has right, by way of compensation, to the premium for another half-year.

§ 121. An apprenticeship may be terminated against the will of the master before its expiration when he grossly neglects the duties imposed upon him by § 118, or abuses the right of paternal discipline.

If the question is decided against the master (§ 108) legal proceedings can be taken against him to oblige him to repay the additional cost of providing for the apprentice elsewhere.

The master is liable in a similar manner if his right to keep apprentices is withdrawn from him (§ 117).

§ 122. An apprenticeship may be terminated against the will of the master before the expiration of its term if he changes his trade or calling. In that case the master, unless there is an agreement to the contrary, is entitled to receive the fee for the ensuing half-year.

§ 123. Articles of apprenticeship are cancelled by the death of the master of the apprentice.

They may also be cancelled at the instance of either party when the master or the apprentice is unable to fulfil the obligations which he has contracted.

§ 124. On the dissolution of his apprenticeship the apprentice may claim a certificate from his master, stating the length of time during which he has served, the knowledge and degree of skill which he has acquired during his apprenticeship, and also what has been his general conduct. If the parties desire it, this certificate, if it contains nothing that is objected to, must be attested and stamped free of cost by the communal authorities.

§ 125. No fees are to be levied on the reception or dismissal of apprentices.

§ 126. The provisions of §§ 105 to 115, and of §§ 118 to 125, with the exception of the second part of § 106, are not applicable to apothecaries' assistants and apprentices, or to merchants, or foremen of works in factories. The position of the latter as regards their relations to their masters and employers is to continue to be regulated as heretofore.

II.—*Factory Operatives.*

§ 127. The provisions of §§ 105 to 114 are applicable also to factory operatives.

§ 128. Children under 12 years of age are not to be taken into regular employment in factories.

Children under 14 years of age can only be employed in factories on condition of their receiving three hours' instruction daily in a school approved by the superior administrative authorities. They must not be employed for more than six hours a day.

Youths above fourteen years of age, until they have completed their sixteenth year, are not to work in the factories for more than ten hours a day. Even these hours of labour may be reduced by the central authority to six, if the young operatives are still bound to attend school according to the system of education in force in different parts of the confederation.

The local police authorities are empowered to allow these hours of labour to be prolonged by one hour, as a maximum, and during four weeks at the utmost, if the regular business of the factory has been interrupted, or an increase of work has been rendered necessary by some casualty or accident of nature.

§ 129. Young operatives (referred to in § 128) are to be allowed half an hour's interval of rest both in the morning and in the afternoon, and a full hour at noon, with liberty of exercise in the open air at each time.

The hours of labour are not to commence before 5.30 a.m., and not to continue beyond 8.30 p.m.

Juvenile operatives are not to work on Sundays and holidays, or during the hours set aside by their spiritual pastors for instruction in the catechism or for confirmation.

§ 130. Any person engaging a juvenile operative for regular employment in a factory, must give previous notice to that effect to the local police authorities.

The employer must draw up a list of the juvenile operatives in his employ, giving their names, ages, residence, the names of their parents, and the time of their entry into the factory or discharge from it, to be hung up in the workroom, and a copy of it must be shown to the police and school authorities whenever they ask to see it. He must report every six months to the local police authorities the number of such operatives in his employ.

§ 131. No juvenile operative can be received into regular employment until the father or guardian of the operative has presented the employer with a workbook ("Arbeitsbuch").

This workbook, prefaced by §§ 128 to 133 of the present law, is to be issued by the local police authorities at the request of the father or guardian of the juvenile operative, and must contain—

(1.) The name of the operative, and the day and year of his birth.

(2.) The name, condition, and address of the father or guardian.

(3.) A certificate of the operative having previously attended school.

(4.) A column for his present school obligations.

(5.) A column for registering his admittance into the factory.

(6.) A column for registering the time of his leaving it.

(7.) A column for the inspector's minutes.

This book is to be kept in the custody of the employer, to be shown by him at any time to the authorities if they ask for it, and to be returned to the father or guardian when the operative ceases to be employed.

§ 132. Special officers, who are charged with the duty of seeing that the foregoing regulations (§§ 128 to 133) are carried out, are invested with all the official authority of the local police authorities, including the right of inspecting the factories at any time.

The proprietors of industrial establishments are bound at any time, even at night, when work is going on, to allow them to be officially inspected in accordance with the prescriptions of §§ 128 to 133.

§ 133. The central authority is authorized to issue exceptional directions for a fixed period, not exceeding one year at the utmost, in respect to such industrial establishments as would be deprived of their necessary working power ("Arbeitskraft") by carrying out the regulations laid down in §§ 128 and 129.

In the case of juvenile operatives already in employment when the present law comes into operation, the notice enjoined by § 130 must be given to the local police authorities within four weeks.

§ 134. Owners of factories, and all persons trading in whole or part manufactured goods, are bound to pay the wages of the workmen employed in manufacturing them in money.

They are not permitted to supply the workmen with goods on credit.

On the other hand, they may furnish their workmen with lodging, firing, the use of ground, regular board, medicines, and medical attendance, besides tools and materials for their manufactures, and reckon this in the payment of their wages.

§ 135. The rules laid down in § 134 apply to members of the families, assistants, agents, managers, overseers, and factors of the employers specified therein, as also to all those carrying on a business in which one of the persons above-named takes a part directly or indirectly.

§ 136. Under the head of operatives ("Arbeiter") (§ 134) are included also those who, out of the factory, prepare for the factory owners, or persons in a similar position, the whole or part-manufactured articles which they require in their business, or who dispose of such articles to the factory owners, without making a trade of selling them to consumers.

§ 137. Operatives whose claims, contrary to the rules laid down in §§ 134 to 136, have been settled otherwise than by payment in money, may at any time exact payment of their claims in cash, without being met by the objection that they have received an equivalent. This equivalent, if it is still in possession of the recipient, or if he has realized anything by it, reverts to the fund mentioned in § 139, Part ii.

§ 138. All contracts at variance with §§ 134 to 136 are null and void.

Likewise all agreements between owners of factories, or persons in a similar position, on the one hand, and operatives on the other, in respect to the latter purchasing their necessaries at certain shops or stores, and in respect to the profits derived from them being applied to any other purpose than to promote arrangements for improving the condition of the operatives or their families (§ 34).

§ 139. Factory owners, and persons in a similar position, can neither sue for the value of goods with which they have supplied operatives in spite of the prohibition, nor refund themselves by deducting the amount from their payments to the operatives, or by any other means, no matter whether the claims have arisen directly or indirectly.

Pecuniary claims of this nature are to be appropriated for the benefit of the sick funds, burial funds, savings banks, or other aid funds established in the commune where the operative resides, for the particular class of operatives to which he belongs. If there are several such funds existing the claim is to be divided equally amongst them all, and failing institutions of this kind it goes to the poor-box.

Part VIII.—Industrial Aid-Funds ("Hülfskassen").

§ 140. The obligation imposed by local statute or by order of the administrative authorities upon persons carrying on an independent industry to contribute to sick, aid, or burial funds, whether these are connected with guilds or established independently of them for artizans exercising an industry on their own account, is abolished. No change is made in other respects in the status of these funds by the present law.

New funds established by independent artizans for the above named purposes, on receiving the sanction of the superior administrative authorities, acquire corporate rights ("Rechte juristischer Personen"), in so far as the acquisition of such rights depends upon the special sanction of the state.

§ 141. Until a federal law has been issued on the subject, the laws of each country relating to sick, aid, and burial funds for journeymen, assistants, and factory operatives, remain in force.

Meanwhile the obligation imposed by local statute or by an ordinance of the administrative authority upon journeymen, assistants, apprentices, and factory operatives, to join a particular sick, aid, or burial fund, is abolished as regards those who prove that they belong to some other sick, aid, or burial fund.

Part IX.—Local Statutes ("Ortsstatuten").

§ 142.—Local statutes are invested with a compulsory power of regulating all those matters connected with industry which the law has transferred to them. These statutes are framed in pursuance of a resolution passed by the commune, after hearing persons engaged in trade who are concerned in the matter. The statutes must be confirmed by the superior administrative authorities.

The central authority has the power of annulling local statutes which are at variance with the laws.

Part X.—Penal Clauses.

§ 143. Apart from the power of withdrawing licenses and the prohibitory power which are conferred by the present law (§ 15, Part II., and § 35), the right of exercising a trade or calling cannot be taken away by a judicial or administrative decision.

Exceptions to this principle, founded upon the excise laws, are to be maintained so long as those laws remain in force.

In like manner, the law of each state, whether compulsory or permissive, in virtue of which the right to exercise an independent industry is withdrawn by a judicial sentence as a penalty inflicted for a breach of the press laws, remains in force.

Those provisions of the laws of a state, in virtue of which the right of publishing and selling printed matter within the limits of the North German Confederation is liable to be withdrawn by an act of the administration, are hereby repealed.

§ 144. Existing laws have to decide how far, independently of the rules laid down on the subject of depriving a person of the right to exercise an industry (§ 143), breaches of professional duty are to be subject to penalties.

The special provisions, however, now in force, as regards the medical profession, and which oblige them under penalties to give medical aid, are repealed.

§ 145. What the minimum of punishment is to be, what the proportion of fine to imprisonment, and what lapse of time is necessary to bar proceedings for the offence specified in § 153, are left to the laws of each country to decide. In respect to all other acts punishable under this section (Part X.), penalties are barred after a lapse of three months.

§ 146. Contraventions of §§ 134 to 136 are punishable with a fine not exceeding 500 dollars (£75,) and, in default of payment, to a proportionate term of imprisonment not exceeding six months. On a repetition of the offence the penalty is to be doubled.

The fines are to be appropriated to the same fund as that into which the pecuniary claims mentioned in § 139 are to be paid, as prescribed therein.

Every sentence, as soon as it becomes legally valid, must be published, at the expense of the person sentenced, in the official organ of the superior administrative authority of the district and in other public journals of the provincial circle ("Kreis") in which the latter and the operative in question reside.

§ 147. The following are to be punished with a fine not exceeding 100 dollars (£15), and in case of inability to pay, to a proportionate term of imprisonment not exceeding six weeks :—

(1.) Any one beginning or continuing to carry on any stationary trade or profession which requires a previous special authorization (whether in the form of concession, sanction, or installation), without such prescribed authorization, or who deviates from the conditions laid down in the authorization.

(2.) Any one, without the necessary authorization, founding an industrial establishment which, either with reference to the situation or nature of the premises in which the business is carried on, or to the locality, requires a special authorization (§§ 16 to 24), or anyone who, without a fresh authorization, makes important changes in the premises, or transfers them to some other place, or introduces substantial changes into the mode of carrying on the business.

(3.) Any one signing himself as a doctor (surgeon, accoucheur, dentist, veterinary surgeon), or giving himself similar titles without having been approved as such, thereby inducing the belief that he is a certificated doctor.

If by doing so he commits at the same time a breach of the inland revenue laws ("Steuergesetze"), he does not subject himself on that account to an additional penalty, but in fixing the penalty this circumstance must be taken into consideration.

In the case referred to under No. 2, the police authorities have power to order the works either to be removed altogether, or else to be placed on a footing corresponding with the conditions under which they were licensed.

§ 148. The following are to be punished with a fine not exceeding 15 dollars (7*l.* 10*s.*), and, in default of payment, with imprisonment for a term not exceeding four weeks :—

(1.) Anyone who, in addition to the cases anticipated in § 147, commences a business without giving the prescribed notice.
(2.) Anyone neglecting to give notice, as prescribed by § 14, of his assuming or resigning a fire insurance agency business.
(3.) Anyone neglecting to notify, as required in § 14, where his place of business is.
(4.) Anyone acting contrary to a prohibition to carry on an industry, issued under § 35.
(5.) Anyone contravening § 43.
(6.) Anyone who, in going about in quest of orders for goods, infringes the rules prescribed in § 44.
(7.) Anyone exercising an itinerant trade or profession without a warrant ("Legitimationsschein").
(8.) Anyone who, in the course of his trade or profession, makes charges in excess of those prescribed or sanctioned by the authorities.
(9.) Anyone grossly neglecting his duties as master towards the apprentices confided to his care.
(10.) Anyone acting in opposition to the provisions of § 107, in spite of being called upon by the authorities to carry them out.

The penalty is omitted in all these cases when the offence involves at the same time a breach of the inland revenue laws.

§ 149. The following are to be punished with a fine not exceeding 10 dollars (1*l.* 10*s.*), and, in case of inability to pay, with a term of imprisonment not exceeding eight days :—

(1.) Anyone who engages in business of an industrial nature, for which a "Legitimationsschein" is required by § 4, without possessing one and carrying it about with him.
(2.) Anyone following an itinerant trade or occupation and not carrying about with him his "Legitimationsschein," or if he transfers it to another person.
(3.) Anyone following an itinerant trade or occupation for which he has received a "Legitimationsschein," valid for a particular district (§ 60), and extending it without authorization to another district.
(4.) Anyone acting contrary to the provisions of § 61.
(5.) Anyone taking unauthorized attendants about with him in his itinerant trade or profession, or anyone serving as attendant to an itinerant trader or professional person without an authorization.
(6.) Anyone transgressing the police ordinances respecting market traffic.
(7.) Anyone neglecting to give the notices or to draw up the lists prescribed in §§ 130 and 133.

§ 150. Anyone who engages or employs juvenile operatives contrary to the rules laid down in §§ 128 and 129 is to be punished with a fine not exceeding 5 dollars, and, if unable to pay, with a proportionate term of imprisonment, not exceeding three days, for every operative engaged or employed contrary to the regulations.

If he has already been punished three times during the last five years under the foregoing rule, he can be condemned to the loss of the right to employ juvenile operatives, for a definite period, or for the future.

If he has already been punished six times during the last five years, he is to be condemned to the loss of this right for at least three months.

Non-compliance with sentences of the above-mentioned kind is to be punished with a fine of four times the amount fixed by the first portion of the present clause, and, in case of inability to pay, with a proportionate term of imprisonment.

§ 151. When the police regulations are infringed in the exercise of an industry by the representative of the person engaged in it, the penalty falls upon the representative ; if the transgression occurred with the previous knowledge of the person represented, and if he has a power of control, both of them are subject to the penalty imposed by law. Should this not be the case, the person represented is bound to dismiss his representative under pain of forfeiting the concession, sanction, &c.

§ 152. All prohibitions and penal provisions directed against persons engaged in industry, trade assistants, journeymen, or factory operatives, on the ground of their co-operating and uniting for the purpose of obtaining more favourable wages and conditions of labour, more especially by means of strikes or discharge of workmen, are repealed.

Any one taking part in such agreements or coalitions can withdraw from them whenever he chooses, without any complaint being lodged against him or objection made in consequence.

§ 153. Any one inducing, or seeking to induce, others by physical force, threats, or outrages, or by placing them under an interdict ("Verrufserklärung") to take part in these coalitions (§ 152) will be punished with not more than three months' imprisonment, unless the general criminal law inflicts a severer penalty.

Final Provisions.

§ 154. The provisions of §§ 128 to 139 apply to the owners of, and similarly to the workmen employed in, mines, works for dressing ores, and pits and quarries worked underground.

The enactments under which the aforesaid workmen are threatened with penalties for gross insubordination, for being persistently refractory, or for leaving their work, are repealed.

§ 155. Wherever reference is made in the present law to the laws of the state, the latter are to be considered to include also the ordinances issued in conformity with them and with the constitution.

The central authority of the confederation will notify what authorities in each separate state are referred to under the titles of superior administrative authorities, subordinate administrative authorities, communal authorities, local authorities, subordinate authorities, police authorities, and local police authorities.

§ 156. Parts I., II., IV., to X. of the present law are to come into operation in three months from the date of its promulgation ; Part III. is to come into operation on the 1st of January, 1870.

The law of July 8, 1868, relating to the exercise of stationary industries, will cease to be operative in three months from the date of the promulgation of the present law.

BRADFORD AND THE WORSTED MANUFACTURE.

By George Taylor.

WE give the industrial portion of a careful and comprehensive essay on the trade and social condition of Bradford, which was presented this month by the local committee of the British Association to members attending the meeting.

The name "Bradford"—*quasi* "Broad Ford"—is derived from a stream, now indeed narrow, but in early times of greater dimensions ; and which, before the drainage of the district became a matter of public attention, was subject to sudden and dangerous floods. The "ford" was at the bottom of the bank on which the parish church stands, and was the nucleus of the town to which it gave its name.

Bradford is situated near the north-western corner of the great Yorkshire coal-field. This extends from a little east of Leeds to a little west of Bradford, and thence southward to the Derbyshire border. To the east of this coal-field a strip of magnesian limestone reaches from near Doncaster to near Darlington. The immediate neighbourhood of Bradford contains an abundant supply of excellent building stone. What is called the "flag-stone bed" is found at Cliffe Wood, Spink Well, Idle, Clayton, Queensbury, and adjoining places. The Millstone Grit at Bradford is about 160 yards below the flag-stone, and comes to the surface in the moorlands a few miles from the town.

The celebrated "Craven Fault" runs east and west, from Wharfedale to near Kirby Lonsdale. At Settle the limestone country drops suddenly down one to two thousand feet. Few parts of England contain grander scenery than this. Malham Cove and Giggleswick Scar are magnificent cliffs, resulting from the Craven Fault. From under Malham Cove flows the river Aire, etymologically the "bright" stream ; a name justified by the sparkling appearance of the water at its source, soon to be defiled, though utilised, by factories and workshops.

The Aire does not run nearer Bradford than Shipley. The hills by which the town is surrounded furnish numerous streams, but these are liable to be nearly dried up in a hot summer ; and, even if that were not the case, they are inadequate to supply the wants of the great community of which Bradford is now the centre. An extensive and comprehensive scheme of water supply, commenced by a private company, and now greatly extended by the Corporation of Bradford, is at present being carried forward. The water is procured from various parts of the hilly district to the north-west, the chief reservoirs being near Denholme, and between Wharfedale and Airedale. These works are so far completed as to be available, not only for the town and its immediate neighbourhood, but for an extensive district outside ; and they are at present providing no less than eight millions of gallons of water daily for a population of 285,583 persons, occupying an area of seventy-one square miles. When the whole scheme is completed, the daily supply will be increased to twelve millions of gallons.

When it is added that the district immediately south of the town contains large quantities of coal and ironstone, which are

GEMS OF INDUSTRIAL ART.—HUNT CUP.

By Fanniere Brothers.

supplemented by additional quantities brought by three railways —the Midland, the Great Northern, and the Lancashire and Yorkshire—it will be seen that the materials essential for carrying on manufacturing and metallurgical processes are abundant. The Low Moor and Bowling Ironworks are situated within a short distance of the town.

By the Reform Bill of 1832 Bradford was created a parliamentary borough, returning two members. It received a charter of incorporation in 1847. The borough extends from the townships of Calverley and Pudsey on the east, to those of Clayton and Allerton on the west; from Heaton on the north to Bierley on the south; and covers an area of 6,508 acres. Its growth has been singularly great and rapid. In the year 1781 the population of the town was 4,200. In 1801, Bradford, including Horton, Bowling, and Manningham, contained 13,264 inhabitants. In 1861 the same area had a population of 106,218; in 1871 the number was 145,830, and at present it is estimated by the Registrar-General at 156,609. The population, therefore, is thirty-nine times as large as it was not quite a century ago. Nor is this all. The staple manufacture of the town—worsted stuffs, of which Bradford is the emporium and metropolis—has extended itself to all the country around where coal and labour have been obtainable. Keighley[1] (the "ley" or meadow of the Saxon thane Kihel) is the town which, next to Bradford and Halifax, is most largely engaged in the worsted manufacture. Its population in 1861 was 18,819; in 1871 it was 24,704. The making of machinery for worsted spinning and weaving is (as well as the worsted manufacture itself) extensively conducted here.[2]

The whole area of the West Riding worsted manufacture may be included in a triangle, of which the base is a line drawn from Halifax to Otley, and Skipton the apex, containing about two hundred square miles. In 1861 the population of this district was 358,698; in 1871, it was 453,047.

The term "worsted" is generally said to be taken from a small town in Norfolk, where the manufacture at one time was chiefly conducted. Ducange, in his "Glossarium ad Scriptores mediæ et infimæ Latinitatis," gives the following etymology:—"Worstede, lana texta, ab oppido Worsted in comitatu Norfolcienci, ejus opificio nobili, sic dicta." But the probability would seem to be that the town was called after the trade, rather than the trade after the town; for in the oldest documents the place is denominated "Wolstede," the place of wool.

However this may be, the rapid growth, in Bradford and the district which it embraces, of the trade indicated by the word "worsted," has been remarkable, and indeed almost unprecedented. Wool had long been spun by hand in private houses, but it was not till the end of last century that spinning by steam-power was established in Bradford. The first steam factory in the town was built in the year 1800 by Mr. Henry Ramsbotham,[3] father of the present Mr. H. R. Ramsbotham, of Allerton Hall, near Bradford. It stood near to what is now called Thornton Road, and was worked by an engine of twenty horse-power. The second factory was built by Mr. Benjamin Peile, a retired dyer, who also built the third mill for his own occupation, jointly with his nephew, Mr. Matthew Thompson, father of the present Mayor of Bradford. A short time afterwards, Mr. Garnett, who had for some time employed domestic spinners at the old "Paper Hall" in High Street, erected the mill at the top of that street, near what was then the high road to Leeds. The one factory of the year 1800, with twenty horse-power, had grown, in the year 1871, into 133 worsted factories within the borough of Bradford alone, with 12,807 horse-power, and employing 27,855 workpeople; and, in the whole of the worsted trade throughout the kingdom, into 630 worsted factories, worked by steam engines of 48,977 horse-power, and employing 109,557 workpeople.[4]

The nature and processes of the worsted manufacture may next be described.

Wool is divisible into two great classes, according to the length of its fibre. Speaking generally, we may say that "long" wool is coarser in fibre than "short" wool; but all long wool is not necessarily coarse, nor all short wool fine. The specific difference between them has been held to be somewhat as follows. Examined under the microscope, "short" wool, it is stated, presents the appearance of being serrated and imbricated —in other words, its fibres are notched like a saw, and bent over one another like tiles overlapping at the edges. In a fibre of merino wool, an inch in length, there are said to be 2,400 of these serrations; in one of Saxony, 2,700; in South Down, 2,080; in Leicester, only 1,860. In "long" wool these saw-like cusps or points are less developed, indeed in some sorts they are nearly altogether wanting. For the production of woollen cloth that wool is most suitable which possesses the greatest number of these serrations, because it is by means of these that the "felting" process, which is the essence of such cloth, is accomplished. On the other hand, the speciality of worsted fabrics is that in them this felting operation is avoided, or takes place only to a very limited extent. Instead of the end to be attained being the uniform matting and interlacing of the fibres, the object is just the opposite, that is to say, the fibres are required to be drawn and spread out separately and evenly. This is done by means of the *comb*, which, in all its forms, aims at disjoining each separate lock or ringlet of wool, and arranging the fibres longitudinally.

English wool comes to Bradford in large bags packed comparatively loosely. Colonial wool, to save freight by lessening bulk, is made up before shipment in small square bales, packed by hydraulic presses of considerable power; and the wool, subjected to such compression, becomes matted so closely, that it cannot easily be opened out. The wool is therefore placed in a sort of oven heated by steam; speedily the tenacious fibres relax their hold, and the mass is then easily spread out into the form of the original fleece.

This fleece is passed on to the wool-sorter's board. It need scarcely be said that all the wool on a sheep's back is not of the same quality, but varies greatly in length, in fineness, and in softness of fibre. The practised eye of the wool-sorter instantly perceives, and his nimble fingers deftly separate, these varieties, which are thrown into "skeps," or large open wicker baskets provided for each sort.

The wool, thus "sorted," must next be washed. Iron tanks are provided, full of soap and water, kept by steam constantly at a high temperature. Into these the wool is thrown, and repeatedly drawn through the liquid by iron rakes, which, moved by machinery above, expose it completely to the action of the detergent mixture. The water is then squeezed out by passing the wool between rollers heavily weighted, and the drying process is completed by quickly-revolving fans, or drawing the atmosphere through it.[1]

The raw material is now white and clean. It has next to go through what are called "preparing boxes," in order to separate the fibres and lay them parallel. "Short" wool passes through the carding machine ("carduus," a thistle, a teazle, was first employed, now, iron wire); "long" wool through "screw-gills," or

[1] It was at Haworth, near Keighley, that the Brontë family lived, and wrote their graphic descriptions of West Riding scenery and character.

[2] The estimated quantity of worsted machinery made in the whole Bradford district is, per annum, 216,000 spindles for worsted yarn, of the value of £183,540; and 16,220 looms, of the value of £266,680. About one-sixth of the spinning machinery and about one-half of the looms are made for export to other countries, principally to Germany, France, and the United States of America.

[3] For a short time Mr. Ramsbotham had as a partner Mr. Nathaniel Murgatroyd, father of Mr. William Murgatroyd, the gentleman to whom, in conjunction with Mr. Waddingham, then of Leeds, Bradford was indebted for the introduction of its first railway accommodation.

[4] This is the official government return; but it may be safely assumed that the estimate is much below the mark. The Bradford Chamber of Commerce affirm that the number both of works and workpeople is considerably higher than is stated. This opinion is based upon the fact that the number of spindles said to be at work in 1871 would barely suffice to produce the quantity of yarn known to be *exported*. By adding to these the number of spindles which are required for the production of the yarn used for home consumption, the total would be more than doubled; the other figures would, of course, have to be altered in similar proportion to make the estimate even approximately correct. As the discrepancy is important, it will be interesting to see how the case was put by Mr. Behrens in a speech before the Chamber of Commerce in May last:—"The number of spindles said to be at work in 1871 was 1,600,000, and taking the production at thirty gross per week for every 144 spindles, it would give 50 lbs. per spindle per year, or a total of 80,000,000 lbs. of yarn. Now, there were exported in 1871 nearly 44,000,000 lbs. of worsted yarn alone, and of stuffs, according to the Board of Trade returns—deducting the weight of the cotton warp—about 80,000,000 lbs. more, which gave a total of 122,000,000 lbs. of yarn for export only. Taking the home consumption at 77,000,000 lbs., which was a low estimate, they found that the total production of yarns amounted to some 200,000,000, which would require at least 4,000,000 spindles instead of 1,600,000, as stated in the returns. The same result was arrived at respecting the number of looms. The average production of one loom being 150 pieces per year, 57,000 looms, which was the number put down in the returns as at work, would give a total production of 8,550,000 pieces. Now, in 1871, there were exported £18,000,000 worth of worsted goods, representing no less than 12,000,000 pieces, which it would take 80,000 looms to produce. And as it was generally calculated that the home consumption was equal to the exports, we got a total of 160,000 looms at work instead of 57,102, as shown in the returns."

[1] From the water that has been employed in washing, the soap and fatty matter are again extracted by a chemical process. The extract is manufactured into candles.

revolving leather straps armed with fine iron teeth. It is thus made ready for "combing."

It is needful for the production of "yarn" that all the fibres of which each lock or ringlet of wool is composed should be drawn out and laid down smooth and distinct; that the shorter fibres (which are to be found even in the longest wool) should be removed; and that all extraneous matters—"bits and nibs" the comber calls them—should be got rid of. The operation which accomplishes these ends is appropriately called "combing." It was formerly performed in the houses of the operatives—generally, indeed, in their bed-chambers—and was all done *by hand*. It was necessary that the combs should be heated, and for this purpose they were placed in an earthenware stove, or "pot," as it was called, which was kept at a high temperature by burning charcoal in it. The wool was oiled to render it more pliable. The vapours generated by the charcoal were deleterious in the extreme. Nor was the occupation hurtful to the bodily health merely. Dirt and stench produced moral as well as physical degeneracy; and the men sought relief from the nausea of their work-rooms in the excesses of the ale-house. The feeling that there was something essentially wrong in the existence of such a state of things led many of the workers to give a willing ear to agitators who increased their discontent; and riots occurred on two or three occasions, which rendered it necessary to call in military aid.[1]

So far as wool-combing is concerned, this source of demoralization, happily, no longer exists; and that operation, which was formerly the disgrace, is now the glory, of the trade. The combing machines are marvels of ingenuity, and even of elegance. Their introduction into Bradford is mainly due to S. C. Lister, Esq. It is necessary that the carded short wool, and the long wool not requiring carding, should be opened out in the direction of the length of their fibres, and so formed into a "sliver," or ribbon, and that the "noil," or shortest fibres not available for worsted yarn, should be taken out. Lightly and gently this operation is effected. Passed under the action of the long, thin spikes of the comb, the locks of wool are drawn out in perfectly parallel lines, each "particular hair" not "standing on end," but laid down smooth, sleek and shining, and the "noil" is quietly passed over into its appointed receptacle. And as no mechanical contrivance in the worsted trade is more curious and beautiful, so none has been more beneficent in its moral influence; for, instead of the co-operation of the workman being accompanied, as formerly, by that loss of self-respect which too frequently results from dirty and deleterious labour, it is now rendered by him as the controller of an apparatus thoroughly cleanly and inoffensive in its working, and marvellous in its results. And although the temperature of the combing-shed is still high—averaging 70 degrees—yet the apartment is large and lofty, and ventilation, for the most part, is amply provided for.

The wool, thus combed, is made up into balls called "tops"—a sort of round "heads." It has now to be "prepared" for spinning. This process consists in passing the "slivers," or ribbons, of combed wool between a series of pairs of rollers, moving with regulated and gradually increasing degrees of velocity, and brought, with corresponding gradations, closer to each other, thus diminishing the space between them through which the wool has to move. The result is to draw out the fibres more completely. This is repeated from six to ten times. The strips of slightly-cohering wool thus gain length at the expense of thickness, and are called "rovings"—the word is probably cognate with the sailors' "reefing," from the Anglo-Saxon "reafian," to pull. The bobbins on which these rovings are wound whilst revolving impart a slight amount of twisting to the wool; and a sort of light woollen rope is produced with the smallest possible amount of strain. It is immediately from these "rovings" that "yarn"—literally, "prepared" wool—Anglo-Saxon, "gyrnan," to make ready—is produced.

The yarn varies according to the quality of the wool from which it is produced, and according to the fineness of thread to which it is spun. In what is called the "fly-frame," for spinning long wool, the spindles have a velocity of 2,500 revolutions per minute. In the "cap-frame" they attain the almost incredible speed of 6,000 per minute, or 100 revolutions per second.[2] The tenuity of the yarn is indicated by the "number," which represents how many skeins, or "hanks"—bundles that one may "hang" up—go into a pound. Thus, "40s." yarn means that in one pound weight there are forty hanks, each measuring 560 yards; "80s." means that in the same weight there are twice as many yards, which must, therefore, be a yarn twice as fine.

It must be noted that the worsted yarn thus produced is used almost entirely for weft; there is only a very small, though just at present an increasing, percentage of worsted warps used.

Cotton warps were introduced into Bradford in A.D. 1834, and produced a revolution in the manufacture of the district. From this point may be dated the most rapid growth both of the trade and the town. Cotton has some great advantages over wool in its employment as warp; it is stronger, and therefore better fitted to bear the stress of looms worked by steam-power; it is ordinarily spun to a finer thread; and, above all, it is less costly. Its use increased with great rapidity; and probably seven-eighths of the pieces now produced are made with cotton warps. For some of the finest goods silk warps are used.

Weaving, like combing and spinning, was originally a domestic operation; and during the time of transition from hand-looms to power-looms, there was a good deal of suffering. The work is now all but universally carried on in the factories, and at least two-thirds of the weavers are females. The mere manual labour is in itself quite light. Steam supplies the motive power; what the operative has to do is to watch the web in its progress, see that the shuttle is kept supplied with the right yarn, pick out any knots occurring in defective weft, and, if any thread breaks, join it together again. A very ingenious contrivance, called the weft fork, which stops the motion of the shuttle the instant the weft breaks, has rendered it possible for one weaver to attend to two and even three looms with no more trouble than one required formerly. The inventor is a Lancashire operative. In looms for the weaving of yarn-dyed figured or "fancy" goods, where a variety of colours has to be introduced in the weft, a number of shuttle-boxes is required, each supplying a different-coloured thread; the action of all these is automatic. In plain fabrics each weaver generally attends to two looms; in figured goods, for the most part, to one only. The faculties demanded of the weaver are sharp eyes and nimble fingers; and it is patience rather than strength that first becomes exhausted. From the beam on which the piece has, in weaving, wound itself, it is now taken, examined by the overlooker, and passed into the hands of the salesman in the warehouse, by whom it is disposed of to the merchant. Pieces undyed are called "grey goods." The dyeing is performed according to the requirements and instructions of the merchants purchasing.

The manufactured goods produced by the operations that have thus been indicated are of great variety. The world is the market for them; there is scarcely a corner of the globe open to British products where they have not penetrated. Speaking generally, they may be divided into two classes, distinguishable according to the "lustre" of their surface, or to the "softness" of their "handle." Most of them are used for the dresses of women and children; some for the lining of woollen garments and for men's light summer coats; others for window hangings and domestic furniture. Many of the names by which the different articles are distinguished were given by the mere fancy or whim of the salesman; others are corruptions of the names of places where the particular goods were first produced; the best names indicate the material employed or the speciality of the fabric itself. One of the oldest productions of the English worsted loom was called a "Say;" it was for many years, and to some extent still is, exported to Italy and the Peninsula for ecclesiastical vestments. It is curious as being known and referred to by Shakespeare, whose father, farming his own land, was himself (Betterton tells us) a considerable dealer in wool. Mr. Walter Savage Landor, whose acquaintance with Elizabethan literature and history was extensive and minute, calls Shakespeare expressly "a wool-stapler's son." In the second part of King Henry VI. a messenger enters Jack Cade's tent, exclaiming—

"My Lord, a prize! a prize! Here's the Lord Say, which sold the towns in France; that made us pay one and twenty fifteens, and one shilling to the pound, the last subsidy." (Enter George Bevis, with the Lord *Say*.) *Cade:* "Well, he shall be beheaded for it ten times.—Ah! thou *say*, thou serge, nay, thou buckram[1] lord."

[1] This uneasiness was aggravated when steam-power was first applied to *weaving* in Bradford. On the 3rd of May, 1820, an attack was made by a mob on Messrs. Horsfall's factory, when two persons were killed and several wounded.

[2] Nothing, perhaps, strikes a stranger more, when looking at the spinning-frame, than how the children dare put their little hands to stop a spindle moving at such a rate, unless it be how quickly they join the broken threads together again.

[1] Buckram was then a woollen cloth, of slight and coarse texture, artificially stiffened.

"Serge" was from the Arabic-Spanish "xerga," a woollen mat or blanket. Gay, who died in 1732, says :—

"Ye weavers, all your shuttles throw,
And bid broad cloth and serges grow."

Another of the oldest worsted fabrics made in Yorkshire is called "Tammy," from the old French word for worsted, "estame," which itself is derived from the Latin "stamen,"—the warp in the loom of the ancients being extended vertically instead of horizontally. We read in Ovid :—

"Aut ducunt lanas, aut stamina pollice versant."

The old "Tammy Hall" at Halifax took its name from this fabric ; and, in 1808, at a county ball given at York, the female fashion of the district manifested its patriotism or its prejudice by appearing in dresses made from this material alone. A worsted stuff now obsolete was called "Amens," a corruption of the name of the town Amiens, from which its manufacture was derived ; as the old worsted tapestry called "arras" was named from the town in Artois. Polonius says in "Hamlet"—

"Behind the arras I'll convey myself."

The material for curtains and other furniture-hangings, called "damask," got its name (like the "damask"-rose) from a place still further distant—Damascus. The prophet Ezekiel bears testimony to the commerce of this place : "Damascus was thy merchant (Tyre's) in the multitude of the wares of thy making, for the multitude of all riches, in the wine of Helbon, and *white wool*." (Ezek. xxvii. 18.) Another old fabric is called "shalloon," as being first made at Chalons. These goods would seem to have been originally used for coverlets. Chaucer describes—

"——— a bedde
With shetes and with *chalouns* faire y-spredde."

In "ye olde usages of ye citie of Winchestre," quoted in the late Mr. Toulmin Smith's work on "Ancient Gilds" (page 350), it is ordained "that non of the citie ne shall don werche qwyltes ne *chalounes* without the walles of the citie."—"Camlets" were originally made, it is said, of camel's hair, the material of John the Baptist's garment. They were made of fine wool in Queen Elizabeth's time, and used for men's apparel as well as women's ; a vestment made of them is mentioned by Beaumont and Fletcher in "The Woman's Prize," Act v. Scene 1. In Shakespeare's "King Henry VIII.," Act v., Scene 3, the porter says to one of the crowd in the palace-yard—"You i' the *camlet*, get up o' the rail ; I'll pick you o'er the pales else." This cloth is called by Chaucer "Cameline ;" in the "Romaunt of the Rose" he says that "False Semblaunt" (Hypocrisy) and "Abstinaunce" walked forth disguised :—

And Damé Abstinaunce streined
Took off the robe of Cameline,
And gan her gratch as a bigine—

that is, dressed herself as a nun or béguine : so that the material was then regarded as too fine in texture for the vows of religion and poverty ; it is now one of the heaviest articles in the trade. "Calamanco," a stout old fabric, was probably derived from the wool of Calamocha, in Catalonia, the only province in Spain where the woollen manufacture is still to any extent carried on. Steele, in the 85th "Tatler," gives us a likeness of a dandified Tim Dapper in "a red calamanco waistcoat." Spain gave a name also to the worsted goods perhaps most extensively known, viz., "Merinos," made originally from the Spanish wool so called, and the wool itself got this name from the fact that the sheep in Catalonia were driven to the high table-land in summer, and to the lower country in winter, by shepherds who were under the control of an official personage—a royal judge and inspector of sheep-walks—called the "Merino,"[1] *quasi* "Maiorinus," the "major" or higher—the superintendent ; just as the "Mayor" of Bradford is at the head of the town where "Merinos" or similar goods are now made. "Moreens" got their name from being "moirés," or watered. "Paramattas" bear the name of a wool-producing district in New South Wales. "Henriettas," made of silk warp and fine worsted weft, were so called by a Bradford merchant after his daughter. "Orleans" cloths are made of cotton warp and worsted weft, the threads of each being equally "plain" on the surface. In "Cobourgs" the worsted weft is brought more prominently to the surface, overlapping the cotton warp with a "twill," or slight ridge. They were introduced as a cheap substitute for merinos, which are made entirely from wool.

Orleans and Cobourg cloths were for a long time the chief articles produced in the trade, and they are still very extensively used for female attire.

Alpaca and mohair goods constitute a distinct variety, and merit a more detailed description. The first of these materials is one of the most modern in its adaptation to English manufacturing purposes ; the second is one of the most ancient mentioned in history. The fabrics produced from them are probably more widely celebrated than any other goods supplied by the Bradford trade.

The word "Alpaca" is the generic name for that form of the "Camelidæ" which is to be found only in the New World. The animal was described more than three hundred years ago by the Spanish historians of the conquest of South America. Writing in A.D. 1544, De Zarate, treasurer-general in Peru, tells us of the long fleeces and fine wool of the "Pacas." J. J. Scaliger, about the same time, calls the animal (in Greek) "Allocamelos"—another camel. One was brought over to Europe in A.D. 1558, and shown in a travelling caravan as a "beast of burden." Joseph D'Acosta wrote that "the ancient sovereigns of Peru had a factory for weaving and artificers for dyeing it, on the banks of the lake Titicaca." The hair of this animal had been brought over into England, and, in one or two instances, attempts had been made to adapt it to the purposes of manufacture. But these efforts had not proved successful, and the material was absolutely unsaleable, when, in the year 1836, it was shown by a Liverpool broker to Sir Titus, then Mr. Salt. The broker frankly avowed that he feared Mr. Salt could make little of it, for other folks had tried, and it had beaten them. Fortunately, Mr. Salt possessed the patience which other experimentalists had lacked. Not disheartened by the failure of his first attempts, he persevered with his trials, and Saltaire is the proof and the monument of his success. As the "works" there are in all respects most complete, and as the institutions annexed to that establishment are no less interesting to the philanthropist than the mechanical processes are to the manufacturer, a brief account of the place shall be given.

It should first, however, be stated that "mohair," the other raw material worked up at Saltaire, is the wool or hair of the Angora goat. The name, according to the old etymologist Skinner, is derived "ab orientali voce *moiacar*, species camelotti." If alpaca is one of the newest of animal productions used in textile fabrics, mohair is one of the oldest. It is grown chiefly in Syria and various parts of Asia Minor, and it is not improbable that it is the material referred to in the directions given to Moses for the furnishing of the tabernacle, which was ordered to be provided with a covering of "goats' hair." (Exod. xxv. 4.) The references to it in the Song of Solomon correspond with the "lustre" which is a distinguishing characteristic of mohair. "Thy hair is as a flock of goats" (Sol. Song iv. 1) may refer to luxuriance of growth, but more probably to its silky brightness and softness. Goods from this material were manufactured in England a century and a-half ago. Pope, in his satire on Lady Suffolk as "Chloe," contained in the second epistle of his "Moral Essays," describes her heartlessness thus :—

"She, while her lover pants upon her breast,
Can mark the figures on an Indian chest ;
And, when she sees her friend in deep despair,
Observes how much a Chintz exceeds *Mohair*."

The modern lady of fashion does not echo Chloe's opinion. There are at present few textile fabrics superior in brilliancy of finish to those made from mohair.

Saltaire, the spinning and manufacturing establishment most popularly associated with alpaca and mohair, is conducted by the firm of Sir Titus Salt, Bart., Sons and Co., and is about three miles from the Bradford Town Hall. The factory was opened on the 20th September, 1853, the day on which Mr. Salt had attained his fiftieth year. The architects were Messrs. Lockwood and Mawson, of Bradford. The engineer under whose direction the shafting and general machinery were prepared and fitted up was Mr., now Sir William Fairbairn, of Manchester. The "works," including the factory, weaving-shed, offices, &c., cover an area of about nine acres. In a speech delivered by Sir William Fairbairn on the opening day he stated that "the nominal power of the steam-engines was equal to 400 horses ; but, working them up to a pressure of forty pounds on the square inch, they would give a force of upwards of 1,200 horse-

[1] "Merino es nome antiguo de España, que quiere dezir tanto como ome que ha majoria para fazer justicia sobre algun lugar señalado ; assí como villa, ó tierra. Y estos son á dos maneras : á unos á que pone el rey de su mano en lugar de adelantado, á que llaman Merino Mayor, y este ha tan grande poder como el adelantado. Y otros hay que son puestos por mano del adelantado, ó de los Merinos Mayores, peró estos á tales non pueden fazer justicia, si non sobre cosas señaladas, &c.," *i.e.*, "Merino is an ancient title of Spain, which is equivalent to a man who has authority to administer justice over some appointed district, either town or country. And they are of two kinds : the one that the king appoints by his own hand in place of an adelantado (name of a governor), called Merino Mayor, and having equal power with the adelantado. The others are such as are appointed by the adelantado or by the Merino Mayors, and these cannot administer justice except, &c." (Cf. Ducange, s. v. "Majorinus.")

power. The length of shafting to be set in motion before all the machinery could be put in operation was 9,870 ft., or nearly two miles, and it weighed between 600 and 700 tons. All that immense mass of matter must be put and kept in motion before it can give power to the various machines which would be fixed in the different departments of the building. He had also ascertained that it would contain 1,200 looms, capable of producing 30,000 yards of alpaca cloth or mixed goods per diem, or nearly eighteen miles of cloth each day. This would give a length of 5,688 miles of cloth per annum, which, as the crow flies, would reach over the land and the sea to Peru, the native mountains of the alpaca."

To this statement it may be added that, with the additional works erected at Saltaire since its opening, and with the increased speed at which the improved machinery is now worked, the productive powers of the establishment are at present considerably above Sir William Fairbairn's estimate.

The majority of the workers employed here have their dwellings in the town of Saltaire, immediately adjoining the works. These dwellings cover an area of rather more than twenty-five acres, are regularly and uniformly built, and were occupied last September by 4,380 persons, for whose comfort, instruction, and amusement all modern approved appliances have been amply provided. Baths, wash-houses, excellent school-rooms, a handsome literary institution, and a beautiful congregational church, minister to their physical and moral welfare; and a park of fourteen acres, pleasantly sloping towards the river Aire, provides recreation and enjoyment for all. Forty-five almshouses for the aged, and an hospital for the sick, complete the arrangements made for the needs of the population. Bradford is doing honour to itself as well as to Sir Titus Salt by erecting his statue near its Town Hall; but Saltaire will remain his noblest memorial. "Si monumentum quæris, circumspice!"

Having thus mentioned the chief productions of the Bradford worsted trade, the question may be asked, what is their estimated annual value?

An approximation to an answer is, in the necessary absence of any official record, all that can be given. Before statistics became a science, the most varying and exaggerated calculations were made, according as the writers were connected with agriculture or engaged in trade. The former wished to sell wool at the highest, the latter to buy it at the lowest price. Accordingly the manufacturers were for preventing the export of wool, whilst the wool-growers cried out for an open market. There is perhaps no article of commerce (corn excepted) about which a greater number of royal edicts were issued in the middle ages of English history than about wool; for it was a ready and constant source whence the royal exchequer might be replenished. Some curious specimens of the guesses made as to the value of woollens and worsted might be given from pamphlets written both on the agricultural and manufacturing sides of the question, but they must be passed over. Readers interested in the subject may collect them from Smith's "Memoirs of Wool."

In later times, estimates as to wool have been made by inquirers less prejudiced and more scientific. Without mentioning a number of others, a recent as well as careful investigation was made a few years ago by Mr. Behrens, sometime president of the Bradford Chamber of Commerce. From his returns the following particulars are extracted:—

"1. In the year 1864, the United Kingdom, it was estimated, had 25,795,708 sheep, supplying 152,272,650 lbs. of wool.

"2. In the same year there were brought into the trade 295,173,239 lbs. of colonial and foreign wool, goats' hair (alpaca and mohair), wool extracts, foreign yarns, and 'shoddy' (*i. e.* manufactured woollens torn up and again brought into the condition of raw material by a machine popularly called 'the devil!')

"3. Deducting the wool *exported* from England (which was 63,254,102 lbs.), there remained, for home use, of wool, &c. (as above), 384,191,787 lbs., worth £57,100,000. To this must be added cotton yarn and other material used mainly for warp, of the value of £7,300,000.

"4. The total value, then, of the wool, goats' hair, cotton, &c. manufactured into worsted and woollen yarns and tissues, in 1864, was £64,400,000. Of this, the worsted portion was £33,600,000; the woollen, £30,800,000."

Nine years have elapsed since this calculation was made. In carrying on the estimate to the present time regard must be had not only to the increase of the machinery employed, but also to the improvement in its productive power. The progress has been great in both respects; and, without going into unnecessary details, an estimate made by the same gentleman, and which is mainly based upon the agricultural returns, and the Board of Trade tables for 1872, shows a corresponding extension of the worsted trade during that period. While the available quantity of wool and of similar animal fibre for all purposes was 384,000,000 lbs. in 1864, it was last year 500,000,000 lbs. (138,000,000 lbs. being of home growth), of which probably 245,000,000 lbs. were required for worsted, and 255,000,000 lbs. for woollen manufactures, producing in combination with cotton, silk, and other materials £46,760,000 of worsted yarns and tissues, and £36,100,000 of woollens.

Nothing shows better the great and constant development of the Bradford trade than the amounts exported to all parts of the inhabited globe, which were

	Yarns.	Worsted tissues.	Total.
In 1842 . .	£637,305	£3,556,963	£4,194,268
„ 1852 . .	1,430,140	4,933,090	6,363,230
„ 1862 . .	3,662,555	5,881,789	9,544,344
„ 1864 . .	5,183,229	10,800,521	15,983,750
„ 1872 . .	6,110,138	20,905,163	27,015,291[1]

The material prosperity of Bradford, so far as the worsted trade is concerned, having been thus indicated, inquiry may next be made into the sanitary, the intellectual, and the moral condition of its inhabitants. Are agencies in operation for their advancement in these important respects, in a ratio corresponding with the increase of the town and its trade? Is the factory labour of the worsted district destructive, as it has sometimes been alleged to be, at once of physical and moral health? That a residence in crowded streets is injurious seems an obvious proposition; but does employment in mills aggravate, in any marked and exceptional way, the tendency to disease?

On this subject a report has been issued during the present year by Dr. J. H. Bridges and Mr. T. Holmes. They state that the labour in worsted mills has "the usual monotonous character of all factory work," but it did not strike them as "severe." "The women attending the carding engines, and those of the wool-combing machines which were under female superintendence, seemed to us to have lighter work than those engaged in the card-room of a cotton factory. . . . . In 92 sides (of worsted spinning-frames) that we looked at we noted 156 broken threads (during the space of twenty minutes), *i. e.* nearly two threads in each were constantly down; and there would, doubtless, be others which, though not broken, eyes more experienced than ours would judge to require attention. There is, therefore, a steady, unremitting call upon the attention, although the strain may not be at any one moment very heavy.

"The temperature of the spinning-room was, in most cases, above 70 deg., rising, in two instances, to 77 deg. and 79 deg. There would appear, however, to be no reason for this whatever, except the dislike of the workpeople for cold, fresh air." . . . .

"The work (in worsted-weaving) is done, in the great majority of cases, by women; a considerable portion of these are married; and the practice of working till the last stage of pregnancy, and of returning to work within a month, sometimes within a fortnight, or even a week, of child-birth, is as common in the West Riding as in Lancashire.

. . . . . "The general appearance of the workpeople in the worsted district struck us as somewhat superior in vigour and health to that of cotton operatives. Cases of marked deformity, such as appear to have been of very frequent occurrence forty years ago, appear now to be as rare as in non-factory districts. Many of the women and children are evidently enjoying robust health.

"Careful analysis of the Registrar-General's records of mortality shows, however, that the adult women of Bradford, Halifax, and Keighley, and their respective neighbourhoods, are liable to a higher death-rate than the average. Taking the period during which the health of women is of the greatest national importance, the period between 15 and 45, the normal rate of mortality, as recorded in the English life-table, is 866 per 100,000. In the registration districts of Bradford, Halifax, and Keighley, including not merely the towns of those names, but the adjacent rural and suburban villages, the death-rates for women of this age are 1,048, 1,135, and 1,197."

The general results of the statistical investigations made by Messrs. Bridges and Holmes are thus stated:—

"That there is a high rate of general mortality in the factory districts.

"That there is a high rate of infantile mortality.

"That there is a considerably higher rate of mortality amongst women of the reproductive age in factory districts than in other manufacturing centres where women are not employed.

[1] Some portion of this extraordinary increase may be accounted for by the advance in prices which took place in 1871 and 1872.

"That a large proportion of this mortality arises from phthisis and other diseases of the respiratory organs."

The last of these conclusions may, perhaps, suggest the question whether a large proportion of this mortality may not be attributed to the neglect, by too many of the workers, of the laws of health, as much as to the conditions of their factory labour; and whether sickness does not originate in their own homes and from their own habits, quite as much as from exposure and fatigue in the mill. The factory workers in the worsted trade are not, as a class, specially chargeable with a want of cleanliness; many of the cottages, on the contrary, are noticeable for their order and neatness; but there is still a large number of dwelling houses in Bradford below—some of them wretchedly below—this standard, where pure air seldom penetrates, and where a good sanitary condition seems impossible. And especially, it must be confessed, that, by too many of the male operatives, the laws of temperance are too little observed, and drink consumes the wages that ought to have purchased comforts and even necessaries for the household.

This fact is indicated by the cases of misdemeanour brought in 1871 before the borough magistrates, a great proportion of which were for drunkenness. Out of a population of 145,830, there were, in 1871, 3,232 cases of misdemeanour. It would be incorrect to suppose that Bradford is worse in this respect than other large towns; but that does not make the fact less deplorable.

THE INDUSTRIES OF NORTH WALES.[1]

The Llanberis Quarries.

THE principal riches of the Carnarvon slate deposits lie between Llanberis and Bethesda, that is, in the Elidir Mountain, which lies to the east of the Llanberis Valley. The district itself is one of great beauty, especially so when it is entered from the north. Here are the two lakes, Padarn and Peris, the picturesque old ruin of Padarn Castle, a circular erection on the banks of Peris Lake, in which the Prince Llewellyn imprisoned Gruffydd Goch for twenty years for betraying him to the Saxons; and in the extremity the romantic Pass of Llanberis, guarded by Snowdon and the Elidir and other high mountains. It is upon the quarries which are excavated from the slate vein as it runs across this beautiful valley that we shall confine ourselves in the present article. The most important by far are upon the eastern side of the Peris Lake, there being numerous other speculations upon the opposite side of the valley of more or less importance.

The Dinorwig Quarries.

This is the name given to the quarries on the eastern side of the Llanberis Valley, now owned by George W. Duff Assheton Smith, Esq., of Vaynol, who inherited the property from the late Thomas Assheton Smith, who was a brother to the grandmother of the present proprietor. Before entering on a personal description of the quarry we may write a brief history of the works, which, when we consider the present magnitude of the quarries and the comparatively short time which they have been worked, must be of great interest to the reader; besides which it is desirable that a lasting record of the growth of such enterprises as these should be made, so that future ages may learn of the difficulties which lay in the way of the old pioneers, before a rugged mountain side could be changed into a prolific source of wealth. The history of all old quarries is much alike. The earliest accounts of them state that they were mere holes dug in the side of the mountain. Each quarryman dug where he found a favourable ledge of the slate vein jutting through the surface. The rubble was thrown upon the nearest vacant ground, most probably upon the slate vein itself; so that in the present day the chief difficulty in the way of making old quarries pay is in remedying the mistakes of the original workers. The earliest known records of the Dinorwig quarries are dated in the year 1780, when there were several private individuals quarrying on the side of the Elidir Mountain, each of whom paid the landowner a premium of one guinea per annum for the privilege. These men were allowed to quarry where and how they liked in return for the guinea. There is no doubt but that the bargain was a good one as far as the workmen were concerned. The old inhabitants state that they grew rich—not according to our most modern ideas of wealth. It appears that the facilities offered for driving a good trade in slates attracted the attention of Mr. Wright and Mr. Hugh Ellis, both of Carnarvon, who in the year 1787 contracted a lease with Thomas Assheton Smith, extending over twenty-one years. These men worked in the northernly portion of the quarry, and although the amount of slates which they produced was probably satisfactory to themselves, it was nevertheless exceedingly small. The slates were conveyed from the quarry in hampers on horseback, and the fact that this was the method of transit for their goods proves that the trade must have been very limited. As the works gradually extended, a new road, called the Allttweu Road, was constructed. At this time the slates were taken to the summit of the quarry, and then sent down an incline to New Quay, on the margin of Padarn Lake, when they were embarked on barges and taken to a place called Clwt-y-bont, and carted from thence to Carnarvon. The next change we note is when W. Wright works the portions of the quarry known as Alltddu and Brynglas, being the lower northernly portion of the quarry. The remainder, called Chwarel Vawr (Big Quarry), was held by three persons, named Morris Thomas, Vachwen, John Parry, and the sons on a neighbouring farm called Tyn-y-mynydd. These parties worked the lower, middle, and upper portions of the quarry respectively. The quarry was worked by the above named persons for some time, but they afterwards sold portions of their interest, and eventually sold their influence to Mr. Glyn Griffiths, of Bodegroes. This gentleman took Mr. Owen Parry, a quarryman of considerable experience, as his manager. The business improved very much under the superintendence of Mr. Parry. The next change was when Mr. T. Assheton Smith obtained possession of the whole quarry in his own hands. In the year 1814 he took in conjunction with him Mr. Turner and Mr. Jones of Hengwrt. Afterwards Mr. Smith took the whole of the quarry into his own control, with the exception of a small portion held by Mr. Turner. The acting managers on the estate were Messrs. Owen Parry and Evan Evans. The former resigned a few years later, and was succeeded by Mr. Griffith Ellis, who was connected with the quarry for upwards of half a century. Now commenced the really great changes in the system of working the quarry. In the years 1824 and 1825 a tramway was made across the Vachwen to Portdinorwic. This step increased the importance of the quarries wonderfully. About 150 tons of slates could be forwarded by this route in a day. But notwithstanding the amount of traffic which went over the line, thoughtful quarrymen saw that a more favourable line could be made. The Vachwen tramway lay over a rather high ridge, while a much more profitable line could be constructed along the banks of Llyn Padarn. This was accordingly constructed in 1841-42. It answered the purpose capitally, and was soon afterwards supplied with a locomotive, which fully supplied the increasing demands of the quarry. The great change in the working of the quarry was also effected about this time. It commenced as the stewardship of Mr. Griffith Ellis terminated and as that of Mr. Robert Parry began. The great change was to form the whole of the mountain into one series of terraces of uniform depth, while the rubbish was transmitted out of the track of the slate vein on either side. This is now being actively perfected by Mr. Robert Parry and Mr. Owen Parry his son, who are the joint managers of the quarry. But the task thus taken in hand is the work of an age. The slate rock is comparatively easy to hew, while the rock which runs contiguous to it, and the posts which pierce it in places, are of adamantine hardness. Therefore vast blocks of rock have been left by the old quarrymen, which now cost an immense labour to be removed. Many valuable portions of the quarry are covered with the rubbish of former excavations, and the galleries in various portions of the quarry are not of uniform depth, so that, as the quarry is being merged into one large system, the waggons could not run continuously along the terraces from one portion of the quarry to another. Under the plan which is being carried out by the Messrs. Parry, the quarry operations will soon become a most systematic and regular work.

The appearance of the quarry from the opposite side of Padarn Lake is very impressive. The whole side of the mountain is ranged into terraces or galleries, each terrace being about twenty yards deep. At the extremities, north and south, the rubble-heaps are extended in terraces. In the centre, overlying some worthless rock which occurs in the quarry, there are also two immense heaps of rubbish, which are encroaching upon the lake. The depth of Padarn Lake is so great that the mounds seem to advance very slowly. In various parts of the quarry there are huge sinews of base rock left, all the good rock having been excavated from around. Some portions have advanced further into the heart of the mountain than others. But, as before stated, this chaos is being gradually transformed into an uniform system.

[1] See also No. 9, p. 161.

There are nine different veins of slate running through the Elidir Mountain. They are known as follows: 1. Green vein; 2. Goch galed, or silky red; 3. Las-galed, or purple-spotted vein; 4. Las rhywiog, or slab or wrinkled vein (then comes a layer of grit called ithfaen coch); 5. Goch-grychlyd, or curly red; 6. Hen las, or banded blue; 7. Goch-galed, or Goch-y-ffridd; 8. Glynrhonwy vein, or las isa; 9. Faengoch Cilgwyn. These veins are also continued on the westerly side of the lake, but have been driven out of their original direction by the upheaval of some of the outlying mountains. Vein No. 9 runs tolerably regularly from Bethesda to Nantlle. The others dip more to the south until they reach Padarn Lake, when there is a slip of a quarter of a mile, the series being thrown to the north again. At the foot of the Elidir Mountain there is a small rising known as Allt-ddu. This has been satisfactorily explained to be the drift from the crater, the nature of the veins and their inclination supporting the explanation. The quarry is divided into two portions—old and new. The division is made by the layer of whinstone which lays between veins No. 4 and No. 5, and between this and No. 1 is the new quarry. The Faengoch is not being worked in the quarry, although it passes through the northernly portion. The old quarry is known by the name of "Garrett," and the extreme summit is called Twll-y-Mwg, or the "Chimney." The new quarry is again subdivided as follows:—There are two lower divisions, and they are the principal. The nearest to the old quarry is the Wellington Quarry and the most southernly is the Victoria Quarry. Between these two quarries a rubble-heap juts into the lake. Above the Wellington are the Matilda, Harriett, and Sophia Quarries; and above the Victoria is the Braich, which forms the highest portion of the new quarry. There are sets of inclines ascending the summits of the Garrett, Wellington, and Victoria Quarries. These are not in the form of one continuous incline, but are formed into a series of gradients. Reaching the Garrett there are eight inclines. Branches turn off from the main inclines on to the various terraces, and along the foot of the mountain there is an incline along which the locomotive traverses.

There is every quality of slates to be found in the Dinorwig quarries, from the best quality, even-grained, durable, and easily split rock, to the hard metallic, and sometimes stony descriptions. The principal failing in the quarry is, that a large quantity of the slates obtained have an inclination towards hardness. Slates of this quality cannot be split up so fine as the softer qualities, but when dressed are very serviceable. In certain parts of the country they find a very ready sale, even in preference to the thinner and better grained qualities; for the opinion as to the proper thickness for roofing-slates differs widely in various parts of the country. We may here point out that very hard qualities of slate cannot be dressed upon the ordinary sawing machines.

The quality of slates in Matilda Harriett and Sophia quarries is, generally speaking, hard, being the hard blue vein, and a small quantity of curly red of good quality; so also is the Wellington, although a very large number of slates are produced from the latter quarry. The very hard slates are like pieces of cast iron. Through the Victoria Quarry there runs a vein of superior quality, from which first-class slates are produced. The cropas in the quarry render great service to the quarrymen in some places. There are five of these divisional lines running through the quarry, the principal being the central one. This is invariably an open seam, requiring no force to separate the rock from either side of it. The cropas are very often the boundaries between the hard and soft rocks. The quality of the slates in the old quarry is invariably very good. Most of the slate veins improve in quality as they deepen, though not invariably. For instance, the Las rywiog, or royal blue, becomes harder as it descends. The "goch galed" vein loses its redness as it descends.

There yet remains the Allt-ddu Quarry to be mentioned. The workings here differ from the remainder of the Dinorwig quarries, being a large pit sunk below the surface, similar to the Nantlle quarries. The quality of the slates is akin to those of the "Garrett," though not quite so fine in texture. The veins are the lower blue, royal blue, and hard red. The pit has gone to a good depth, the rock being raised from it by means of inclined chains.

[Appertaining to the quarry there is a large and well-planned work-building. The building encloses a quadrangle eighty yards by sixty. It consists of a foundry, smithy, joinery, fitting shop, engineers' shops, &c., supplying all the wants of the quarry. The motive power used throughout the works is derived from a large water-wheel, the water to turn which is brought from the opposite side of the quarry. The breadth of the water-wheel is six feet, and its diameter forty-eight.]

The position of the men in this quarry regulates more or less the position of the men throughout the district. For instance, the pay-day is always a large fair day in the district, and so long as the large majority of men who work in the Dinorwig quarries are paid every four weeks, the men who work in the other quarries prefer being paid at the same time. The hours are also ruled in like manner. The working hours are from 6 a.m. to 5.30 p.m. The meal-times are from 10 to 11 a.m., and from 3 to 3.30 p.m. Throughout the quarry there are eating-houses built for the convenience of the men at meal times. There are also barracks built in the quarry, where those workmen whose homes are at a great distance reside during the week. Formerly the "barracks" were scattered up and down the quarry, but the present managers found these situated in such inconvenient places for the workmen that they have now built a small street of model cottages in the lower part of the quarry, and within easy access to the village.

FETTLING.

WE are not quite sure that the word with which we have headed this article will be found defined in the sense in which we use it by any of the lexicographers of the day who are accepted as authorities by the writers of English or their readers. At the same time, however, we feel that by all men individually acquainted with iron manufacture it will be thoroughly understood, and not only understood, but recognized as the embodiment of one of the great practical difficulties of the industry. Many years ago, ere yet a Siemens or a Danks had been heard of, when in fact boiling on iron bottoms had not very long superseded the old arrangement, we remember sitting down in a forge somewhere in South Wales and talking to an old puddler on the very subject of which we now propose to treat. The solid bottoms had disappeared, and the new-fashioned iron ones with a clear draught and current of air underneath were fast coming into use. This was, of course, a topic of conversation of very considerable interest to our friend, and we discussed at some length the different points of the case. After, however, these had been all gone through, the old man finished by saying, "We shall still have the *fettling* to look to." Now, strange to say, with all the knowledge and skill, chemical and other, which have long since then been brought to bear upon the operations of puddling, this very difficulty of fettling is one with which our most modern inventors confess they have trouble in contending; and if they do not, far be it from us to say that they do, acknowledge themselves beaten, they nevertheless allow that up to the very hour of our penning these words no definite and absolute solution of the problem of what is the best fettling, and where it is procurable, has been arrived at.

At the first time of which we write the ordinary material used in South Wales was limestone. At some few favoured spots in the neighbourhood of works where charcoal sinking-down fires were blown, the cinder from them was of course only too eagerly jumped at for fettling purposes; but these instances were merely the exceptions which go to prove a rule. Now looking at limestone, in the first instance, the great objection to it was clearly this, that with anything like a strong iron, throwing a thick cloggy cinder, it was apt to make the puddled bars red-short. And in corroboration of this we may refer to Bauermann, who says, "Limestone is sometimes used for this purpose (fettling), but it does not appear to be generally advantageous, except as being less liable to waste, as it does not contribute to the decarburization of the metal and thickens the slag, and may prevent welding, producing a red-short iron if mixed accidentally with the ball." It may be well here first to note that there are two distinct cases of fettling—the first the ordinary repairing round the sides and making up of the bottom which is necessary, more or less, after every heat; and second, the filling up of *any holes* that may have been eaten in. For the first we have seen very successfully used the larger lumps of red hematite ore, and the sides then lined with the smaller particles of the same mixed with water to a pasty consistency and applied with the paddle, a tool somewhat resembling the baller's peel, or indeed not unlike the ordinary skulls used by boatmen. There is certainly an advantage in using this ore, provided it can be procured at a reasonable rate, but it must be remembered that however much iron-bearing fettling may conduce to a good yield of puddled bar, even this gain may be purchased too dearly. Osborn, however, says on this head, "The ore is either put in large pieces around the inside of the furnace to protect the boshes, or charged in small fragments with the metal, like the addition of cinder." This last, we take it, means hammer slag or roll scale. "What kind of ore is best adapted for this purpose is in some degree a scientific question, but experience shows that none answers so well as magnetic ore." And to give our own opinion, we certainly think that in almost nine cases out of ten red hematite ore will be found the best fettling. With

reference to this we may also observe that, when some years past it was attempted to introduce the European method of manufacturing iron into Southern India, and puddling was tried as part of the process of conversion, a most admirable refractory fettling was found in a species of hematite containing, however, a very considerable percentage of titanic acid, and obtained from an island named Honawr, or Pigeon Island, situated in the Indian Ocean, off the coast of Goa, which island itself is nothing but a solid mass of this ironstone rising almost perpendicularly out of the water.

Another well-known substance for fettling, one, perhaps, as much in use as any other, is commonly called by the not inexpressive term of "bull-dog," which is a material produced by roasting or calcining tap cinder and hematite or magnetic ore, and mixing them together, this forming a very refractory silicate of iron, which is as a general rule, we think, in good repute with the workmen. At most of the works on the eastern coast and in the Cleveland district a residuum from the sulphuric acid works called "blue Billy" is much in use. Burnt pyrites and finely crushed magnetic ore are also very frequently employed, with this objection only, to the first, that it can add nothing to the yield of the furnace, and to the last, that it is frequently an extremely expensive material.

Before leaving the question of fettling for ordinary puddling furnaces, we may just for a moment glance at the use of water boshes, which, if not a method of fettling in the abstract sense of the word, is yet a mode of protecting the sides of a furnace which makes it almost identical therewith. We have seen these used, but we cannot say much to our satisfaction, although at first we were much pleased with the idea. Truran, an authority perhaps at the present day a little out of date, but nevertheless one of the most careful and painstaking of the writers on iron metallurgy, says—"It is a matter for serious consideration whether the employment of air or water boshes is attended with real advantages. Contrivances of this kind are usually proposed on the score of greater economy in some material. In the case of the boiling and puddling furnaces they are a saving in the wear of the brickwork, rendering the interior of the furnace more durable, and consequently enabling the furnace to be worked with less repair. By repair we allude to such as is effected by the puddler with clay, calcined cinder, or other materials. The direct saving in brickwork may be ascertained, but the value of the improvement in quality cannot be so easily appreciated. Against these advantages there must be placed the absorption of heat by the boshes. In a puddling or other furnace a great heat is required to be generated quickly and maintained with the least consumption of coal. The escape of caloric otherwise than over the metal under operation should be prevented by using in the construction of the inner lining as perfect a non-conductor of heat as may be available for the purpose. Where iron boshes are employed, the temperature of the water is brought down by the ready conduction of heat; and as a current of air cannot absorb the caloric as fast as it is communicated by the iron, a current of water has been used. The principle of economizing the heat evolved by the fuel is thus altogether abandoned, and facilities afforded for its escape. In all estimates, then, of the advantages derivable from water boshes, the loss incurred by the escape of caloric in the water must be taken into consideration as well as the loss of metal displayed by inferior yields. By measuring the quantity of water, and taking its temperature before and after leaving the furnace, the quantity of coal which is consumed in elevating it to the higher temperature may be readily ascertained." Now with this we in great measure agree, if not fully, at all events in part; for in places where refractory fire-brick is scarce, (they have cost ourselves at one furnace in the Far East a shilling each,) the water bosh is distinctly a saving; and again, at any works where the bricks contain much silica, and wood fuel is used, water boshes and even the water bridge will be found desirable, from the fact that the potash in the fuel forming with the silica a silicate of potash, the sides, neck, &c., of the furnace in a short time melt away and run down like so much glass unless so protected.

Passing from this to the consideration of the fettling used in the new processes of conversion, we will take first of all that of Bessemer. So far as our information extends, we understand that in the Sheffield district, and indeed through most parts of England, the converters are lined with a siliceous sandstone found below the coal measures, and named ganister. To prepare this it is generally triturated to a fine powder and mixed with a small quantity of powdered fire-brick. It may, however, be used alone, and sufficient water ought to be added to render it plastic and slightly coherent. The mode of application is the well-known one of ramming the mixture between the sides of the converter and a wooden core or pattern of a somewhat smaller section.

Coming after Bessemer, but still bringing forward an invention which, although yet, comparatively speaking, in its infancy, is yet apparently destined to influence the iron trade very considerably, we have Danks, and in an address which he delivered at the meeting for 1871, of the National Association of Iron Manufacturers, held at Philadelphia, he spoke as follows:—"In regard to the furnace itself, the first lining, or what I call the initial lining, is composed of a mortar made of iron ore and lime, which when fresh is held in place by the projecting flange of the interior of the furnace. When dry it is as hard as a rock. In lining the furnace each division or part is filled by itself. This initial lining is practically indestructible. The puddling lining, or fettling, and for which the initial lining acts as a base only, should be a pure oxide of iron, with not more than six per cent. of silica. If the percentage of silica is greater, it melts at too low a heat, the object of this furnace being to puddle at the highest possible degree of heat. In preparing this fettling we use finely pulverized ore—Iron Mountain, Port Henry, or any good fettling ore which is melted on the bottom of the furnace—thus forming a bath of liquid ore, into which lumps of ore are thrown and allowed to set, which they do almost immediately. The furnace is then turned over until another part is fettled, and so on till the whole is done. The object is to get as rough a surface as possible, and when thus lined the furnace no longer presents an interior cylindrical surface, but may be of many sides." Added to this initial lining there is apparently another used to supplement it, but unfortunately we do not find in Mr. Danks' speech any description of it, nor have we alighted on the particulars elsewhere. There seems to be a species of ore named Fix, used for this purpose at Mr. James J. Bennett's works, Pittsburgh, Pa., but whether this be the material referred to or not we regret we are not in a position to state.

Kirwan, again, states that a mixture of thirty parts magnesia, twenty parts silex, and fifteen or twenty parts lime, make a compound absolutely infusible, and the late Mr. Baynton, also an inventor and patentee of a rotary furnace, was of opinion that in localities where these materials exist and can be obtained cheaply, they would probably make a good initial lining.

Following Danks as a reformer of our methods of manufacturing iron, comes Dr. Siemens with his direct process; and he, too, has found one of his difficulties in the fettling. In the learned doctor's reply to the question which had been put to him at the meeting of the Iron and Steel Institute, Willis's Rooms, on the 29th April, 1872, with reference to the proposed use of bauxite, so called from Baux in France, which we understand is a silicate of alumina, constituted of 45·53 alumina, 52·45 oxide iron, and 2·02 silica, he said, "With regard to the price of bauxite he could hardly speak with confidence as yet. The mineral was found in large quantities in the South of France, in Austria, and also in Ireland; and as there was no present use for it, the probability was that it would be obtained cheaply, and the process of converting it into material for the lining was certainly not an expensive one—not more expensive than that of fire-brick making." Mr. Snelus, at the same meeting, mentioned a patent of his own for grinding limestone into the plastic condition of ordinary clay, on which he found, if the furnace were kept constantly in use, the temperature had no action, and it formed a hard, compact, and infusible lining.

To this Dr. Siemens replied, "That hitherto he had not been able to obtain lime in such a form as to resist permanently the effects of scoriæ; but it was quite possible, and he might say that he was now engaged upon a course of experiments at Birmingham, with a view to substitute lime, in some cases at any rate, for bauxite in forming a lining."

Dr. Siemens further referred, in another portion of his discourse delivered at the same meeting, to the difficulty of finding a material to resist the excessive heat necessary to carrying out the ore process. Ordinary Dinas bricks, which are considered, he said, "the most refractory material in general use, would be rapidly melted, but a brick, specially prepared by crushing pure quartz rock, and mixed with no more than 2 per cent. of quicklime, to give cohesion, answers well. The hearth of the furnace is made of white sand, with a small admixture of more fusible fine sand, which mixture sets exceedingly hard at a steel-melting heat, and possesses the advantage of combining into a solid mass, with fresh materials introduced between the charges, to make up for wear and tear. The hearth and the furnace-roof, if of the materials just specified, are very little attacked when the Siemens-Martin process is used, although the heat must be sufficient to maintain wrought iron, containing only a trace of carbon, in a perfectly fluid condition. If pig metal and ore (fused together with the necessary amount of flux) are used, the furnace also stands well; but the use of raw ore entails the disadvantage of a much more rapid destruction of the furnace. Even magnetic oxide of the purest description necessitates the addition of raw lime for the formation of fusible slag, with the silica in the pig, and from the silica furnace-bottom, and the dust arising from the

lime and the ore causes the silica bricks to melt away rapidly, so that after perhaps one month's usage, the 9-inch arch of the furnace may be reduced to the thickness of from one to two inches." Here, then, is another instance of the difficulty of obtaining a thoroughly refractory material, if not exactly for the fettling, at all events, for the construction of the furnace.

A few words now on a patent which has recently been brought forward, and which, although not exactly fettling, strictly so called, is yet so intimately connected with it as to be a cognate subject. We refer to Messrs. Greener and Ellis's oxide dry-bottoms for mill-furnaces. Speaking of altering a sand-bottom furnace to the new method, Mr. Greener directs that the sand should be cut up to a depth of four inches at the fore-plate, sloping down towards the back, say eight inches, and the surface covered with broken ore or fine oxide if preferred. On the top of that the bottom is to be made, composed of coarse ground oxide sloped down towards the flue, where a spout is placed to let off the fettling. And the main advantage claimed is, that this "being a dry oxide bottom, it has all the advantages of the cinder bottom, without the disadvantage of the waste of iron when the lower part of the pile is immersed for any time in liquid cinder." The question here seems to be that of expense as to the cost of the oxide used; but although testimony to its utility has been borne by the managers of several well-known iron factories, notably at the Rise Carr Works and the Skerne Iron Works, the process seems as yet so far in its infancy that we must withhold our verdict until further evidence is before us.

Here, for the present at least, we must leave the consideration of "fettling," certainly so far as we ourselves are concerned, without being able to come to any distinct conclusion as to what really is the best material. The circumstances of the manufacture of course are varied at different works, but the principal essentials of the refractory material are the same at all, and what that material is remains, we fear, as yet a *quæstio vexata*.

STRIKING OIL.

A CORRESPONDENT of the "Times" sends from Petrolia the following account of a successful experiment in the operation called "striking oil":—

"Prospecting for gold, with an occasional hunt after a diamond, although it sometimes turns out to be a wild-goose chase, is exciting while it lasts. Pearl-fishing is not bad fun; but there are few mercantile pursuits that afford more thorough gratification than striking oil. Given an area of 200 acres, it is required to select the exact spot in which there may be the greatest chance of a hole, 4 in. in diameter, striking the oil reservoir. What a pity it is that absolute certainty exists but in very few things. Even mathematical truths are sometimes doubted. It is said that if one could only hit off the exact spots where a rainbow joins the ground, a pot of gold would be found beneath. There does not appear to be any tradition of this kind connected with oil, but it is well known that there are oil seekers, or prophets, who, by the aid of certain divining rods, profess to indicate the precise spot where the oil shaft should be driven.

"My first speculation of this kind was made last spring, in the oil region of Petrolia, Ontario. It is scarcely necessary to say that we resolved to have nothing to do with prophets, but at the same time we thought it prudent—just for the look of the thing—to propitiate the goddess of Chance by a little necromancy of our own. We had received permission, on certain favourable conditions, to test a piece of waste forest land, comprising a square plot of 200 acres. We accordingly directed the surveyor to run two lines through the centre of the plot, from north to south, and from east to west. These lines crossed through a gigantic elm, a very patriarch of the forest. We cut this tree down and grubbed it up by the roots; we then joined the lines, and exactly at the junction we commenced sinking the shaft. This consists of a hole about 4½ in. in diameter, drilled straight into the ground. For the first 100 ft. or so the operation is comparatively easy, the hole generally running through a stratum of blue clay. Then follows about 175 ft. of soapstone or soft rock, interspersed with shale and limestone; and, lastly, comes about 200 ft. of hard limestone, in which are found the oil veins.

"Apparently it is possible to drill within a few inches of a vein without touching or tapping it; a venture of this character is termed a 'dry hole,' and frequently turns out a dead loss. Not always, however, for—necessity being the mother of invention—we have devised an 'earthquake' shell, by the judicious application of which a hitherto dry hole may be converted into a valuable property. The torpedo, under certain circumstances, may be advantageously applied in works of peace as well as in operations of war, and the 'earthquake' shell, however formidable in name, is a very simple and effective contrivance. It consists of an iron or wooden cylindrical case, which can be filled with dynamite, gun-cotton, or other explosive substance, and exploded at any distance down the 'dry hole.' The duty of this torpedo is to shatter the hard rock in the immediate vicinity of the explosion, and thus to tap all the oil veins within the sphere of action. It is lowered by a rope, and fired either by a heavy weight, which runs on the rope and falls on a copper cap in the head of the case, or by electric agency. The oil is usually found at depths of from 400 ft. to 500 ft., and is brought to the surface by means of powerful pumps; but occasionally a 'flowing well' is hit upon. Sometimes a vein is struck which, in addition to oil, contains a large quantity of inflammable gas, and the oil is forced up to the surface by the natural pressure of this gas. A hole of this character presents the appearance of an artesian well. The probability, however, of striking a flowing well is very remote; in fact, there is a saying that a man runs as good a chance of being struck by lightning as of striking such a well. Be that as it may, we rapidly rigged up our little wooden shanty, with smoke-stack, machinery, &c., over the 'location' and got to work. The cold was very great—there is a considerable difference between the climate of Petrolia and Kent—so we had to keep a stove burning night and day to render the temperature at all endurable. Sometimes the stillness of the air, out in the wild forest, was nervously oppressive, while the smothered click click of the tool as it dug into the bowels of the earth was the only sound which fell upon our ears. One by one we passed through the blue clay and the soapstone, and at length struck against the hard rock at the depth of 260 ft.

"Now commenced a time of eager expectancy. We might hit upon a vein at any moment, or we might pound away for another 250 ft. and find a 'dry hole' for our trouble. There is, however, an infinity of degrees in oil seeking, between immediate certainty and protractive impossibility. Many persons look upon events as scarcely probable except in one way; if the probability of an event is very great, they take it for certainty; if, on the contrary, it is very small, they estimate the event as impossible. Now the probability in our case was neither very great nor very small. We had a fair chance. About eight o'clock one evening we were punching away at the hard rock, at a depth of 370 ft., when suddenly the tool appeared to drop into a hole. *Eureka!* Before we could realize our success up came the rush of highly-inflammable gas which always precedes the oil. Now, as before mentioned, there was a comfortable stove handy, besides two or three naked lamps standing about, and if we had not cleared out of that shanty pretty quickly we should have been burnt to death. As it was, the whole building was on fire in a minute, and it was only by the greatest exertions we saved it. Now for a cork to close the hole! We had no idea at first that we had really struck a 'flowing well,' but after stopping the hole as well as we could with mud and clay to prevent the gas catching fire, the oil welled up to the surface and overflowed. It was impossible to bottle it down, it would come up. Fancy a column of oil four inches in diameter squirting up, sometimes to a height of 40 ft. in the air, and falling in a shower of spray like the fountains in Trafalgar Square. It flowed thus for two days before we could get tanks built to hold it. It now flowed through a pipe at the rate of about 40 barrels a day. If it only holds at this rate, it will be a paying concern; but experience has shown that the rate will gradually diminish until ultimately we shall have to pump. Our well, however, is very favourably situated, and there is no other well near as yet, nor likely to be for some time; so that we have no fear of being 'tapped.' If your neighbour sinks an adjacent hole and taps your well, it is as bad as taking the bread out of your mouth. We have now erected two enormous vats or tanks close to the shaft, and it is an interesting sight to see the oil pouring up out of the ground of its own accord into the vats at the rate of 40 barrels a day, particularly as it rapidly turns to gold. A barrel of crude oil is worth $1, so that this well alone brings us in at present about £8 per diem."

IMPROVED PLANER BAR.[1]

WE live in an age of condensation—an era in which the all-absorbing question is not to produce an indefinite number of entirely novel ideas, but to combine, condense, or, to use an apt vulgarism, "boil down" the knowledge we at present possess into the very smallest compass in order to make space for future acquirements. That oft-quoted individual who confers a benefit on mankind by making two blades of grass

[1] From "The Scientific American."

spring up where but one grew before, would fail to comply with the modern requirements of a public benefactor; the problem is now not to produce two blades, but a single small one having the combined value of half a dozen.

We are led to this thought by an examination of the ingenious device which forms the subject of this article and the accompanying illustration. It is one of those inventions which indicate the result of long experience in the practical use of machinery, a crystallization, in fact, of ideas gathered while watching the hard metal yield before the cutting blade, and now presented, probably in the simplest form compatible with efficiency, to supply the place and perform the duty of more extended, costly, and elaborate mechanism.

In brief, the device is a planer bar; its object, to reach through work on planing machines, and thus serve to perform a large proportion of the labour of slotting and shaping apparatus, at, of course, a materially decreased expense. It consists of a heavy shaft, A, at the rear of the planer, which rides upon centres, B. On this shaft the bar, C, is pivoted; so that by this mode of connection a universal joint is obtained, and the outer end of the bar rendered capable of motion in all directions. Near the centre of the bar is a pivoted box, D, from which a pin projects, which is securely fastened to the tool post and carriage. The bar is therefore subject to the movements of the latter, and is regulated by the ordinary feed motion of the planer. At E, the tool end is represented as operating on the inside of a wide casting.

It is claimed that the ability of the device to reach through work is unlimited, and that it will plane one-third the length of the planer; while its action being of an end thrust character, it will cut all that the machine is able to pull without chattering. Our illustration presents so enlarged a view of the invention that any further details are unnecessary to insure its comprehension.

Chemistry applied to the Arts, Metallurgy, Chemical Manufactures, and Allied Subjects.

ABSTRACTS FROM FOREIGN PERIODICALS, TRANSACTIONS OF CHEMICAL SOCIETIES, &c.

§ 1. *Acids, Alkalies, and Salts.*

PURIFICATION of Hydrochloric Acid.—ENGEL adds hyposulphite of potassium to the acid (4 or 5 grammes per litre); arsenic if present is reduced, and a purified acid can be obtained by distilling the liquid clarified by settling and decantation. *Comptes Rendus*, 76, 1139.

Preparation of Valerianic Acid.—PIERRE and PUCHOT add cautiously a cold mixture of 1,400 grammes sulphuric acid and 800 of water to a mixture of 3,500 of water, 1,000 powdered potassium dichromate, and 1 litre of pure amylic alcohol; the whole is well agitated and kept at a temperature of 11° or 12°; amyl valerate, boiling at 175° to 192°, separates as an oily layer. This is skimmed off and heated with 400 grammes of potash and 200 of water per 1,000 grammes of valerate; when the re-action is complete the regenerated amylic alcohol is distilled off and used over again, whilst the residual valerate of potassium is distilled with diluted sulphuric acid.

When pure valerianic acid boils at 178° at a pressure of 760 millimetres, and has the specific gravity 0·947 at 0°, 0·8972 at 54·65°, 0·8542 at 99·9°, and 0·8095 at 147·5°. The author gives a table indicating its specific gravity for every interval of 10° from 0° to the boiling-point. *Annales de Chimie et Physique*, [4], 29, 228.

Preparation of Bromacrylic Acid.—WAGNER and TOLLENS prepare this acid by heating β-bibromopropionic acid (prepared by oxidizing bibromopropylic alcohol, formed by the combination of bromine and allylic alcohol) in contact with excess of alcoholic potash. Bromide of potassium and bromacrylate of potassium are produced, readily separable by crystallization, as the former is much the more soluble of the two. Free bromacrylic acid is obtainable as a crystalline mass by souring the potash salt with sulphuric acid, agitating with ether, and evaporating the ethereal solution obtained. It melts at 69° to 70°, decomposes on heating before it begins to boil, and unites with hydrobromic acid when digested therewith, re-forming the original β-bibromopropionic acid. *Berichte der Deut. Chem. Ges. vi.* 512.

Alkaloids in Cinchona Bark.—P. CARLES finds that the distribution of alkaloids throughout the bark of various plants of the cinchona genus is not uniform. Thus, he finds the following numbers in 1,000 parts of bark:—

Cinchona Calisaya.

	Fine Bark.		Thin Bark.	
	Quinine.	Cinchonine.	Quinine.	Cinchonine.
Outer layers	23·40	5·20	20·70	4·40
Inner layers	13·20	4·80	14·40	3·60
Entire bark	20·40	6·40	17·70	4·80

	Cinchona Lancifolia.		*New Granada Bark.*	
	Quinine.	Cinchonine.	Quinine.	Cinchonine.
Outer layers	24·60	5·50	3·90	7·60
Inner layers	6·60	3·20	Nil.	8·00
Entire bark	8·10	3·60	2·01	11·20
Intermediate layers	11·10	4·80	traces	8·40

	Bright Red Bark.	*Cinchona Succirubra.*		
	Quinine, Cinchonine, and Quinidine.	Quinine.	Cinchonine.	Total Alkaloids.
Outer layers	21·60	19·60	17·00	36·60
Inner layers	14·80	6·40	10·00	16·40
Entire bark	20·25	10·60	34·76	45·40
Intermediate layers	11·20	12·00	11·10	23·20

	Huanoco Bark.		*Loxa Bark.*	
	Cinchonine, and Cinchonidine.	Quinine.	Quinine.	Cinchonine.
Outer layers	47·00	traces	traces	1·40
Inner layers	45·70	none	none	traces
Entire bark	51·40	traces	traces	2·20

Quinine appears to diminish tolerably regularly from the outer layer inwards; cinchonine, on the other hand, is variably distributed. *Pharm. J. Trans.* [3], *iii.* 643.

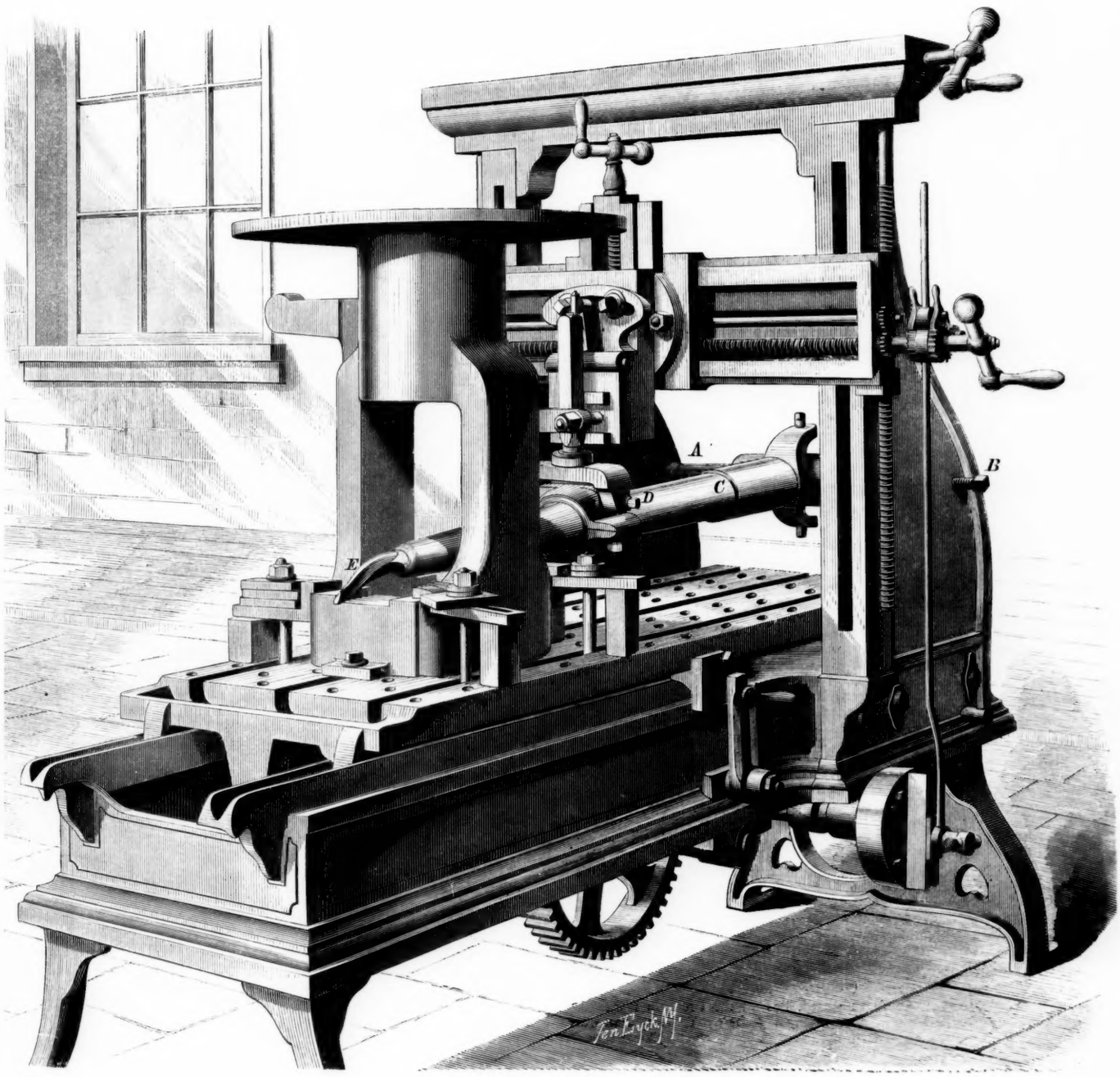
Prizes offered for the fixation of Atmospheric Nitrogen, and the production of Mechanical Force without the use of Carbon.—Count DOUHET proposed in the National Assembly (July 22nd) a prize of a million francs (£40,000) to the inventor of a process or processes whereby atmospheric nitrogen can be manufactured into ferrocyanides, prussiates, nitrates, or ammoniacal salts, so as to furnish manurial matters without the use of animal products at a cost of not more than 90 per cent. of the prices of the nitrogenous manures now in the market. Also a prize of a million and a-half of francs (£60,000) to the inventor of a process whereby motive power shall be gained without employment of vapour pressure or explosive gases, at a cost of not more than 75 per cent. of the present price of motive power from fuel. *Les Mondes, xxxi.* 543.

Indium Alum.—C. ROESSLER has prepared this salt crystallizable in octahedrons and isomorphous with ordinary alum; it is very soluble in water, one part of water dissolving two of the alum at 16°, and four parts at 30°; at 36° a strong solution deposits a white salt, containing less water of crystallization. *J. Pr. Chem.* [2] 7, 14.

Preparation of Phosphonium Iodide.—HOFMANN dissolves 400 grammes of phosphorus in its own weight of carbon disulphide, and then adds the equivalent amount of iodine (680 grammes) little by little; the disulphide is then distilled off in the water bath, the residue warmed, and 240 grammes of water allowed to flow in very cautiously, a stream of carbonic acid gas being passed through the apparatus during the latter operation. *Berichte der Deut. Chem. Ges. vi.* 286.

Artificial Atacamite.—C. FRIEDEL states that this copper ore can be produced in brilliant green crystals by heating to 250° for eighteen hours in a sealed tube a solution of ferric chloride with suboxide of copper. *Comptes Rendus, July* 21, 1873.

Enamel for "Muslin Glass."—BENRATH has examined a glass of this kind from Pivont, Charleroi. The enamel was very regular and homogeneous, and the surface could be readily cleaned; weak acids had no action on the enamel; concentrated nitric acid produced no change in three days; sulphide of ammonium, however, gave a greyish tint, whilst liquid hydro-



IMPROVED PLANER BAR.

fluoric acid showed that the enamel was only incorporated on the surface of the glass. The substance giving the "matt" was very fine and delicate, and of a white tint, with a brownish-yellow shade; dilute acids dissolved out lead oxide and boric acid; hot water had no action on it. Its composition was—

Silica	42·99
Boron trioxide	6·25
Carbonic acid	trace
Stannic oxide	7·01
Lead oxide	37·78
Ferric oxide	0·11
Alumina	0·07
Potash	2·95
Soda (by difference)	2·84
	100·00

which represents a mixture of the following ingredients—

Sand	100 parts
Litharge	110 „
Crystal	110 „
Anhydrous borax	25 „
Stannate of potash	25 „

Dingler's Polytech. Journal, 207, 402.

The Potash-salt Mines at Stassfurt.—T. BECKER publishes an extended description of these mines. Stassfurt is about 20 kilos. from Magdeburg, on the Anhalt frontier. The geological formation on which it lies is the variegated sandstone. The presence of a bed of rock-salt below this stratum was suspected in 1838. Borings were executed by order of the Prussian Government, and in 1851 the presence of a deposit of rock-salt, at least 330 metres in thickness, was ascertained. The formal working of the mines began in 1857. Before reaching the salt it was necessary to sink 260 metres through the sandstone, the gypsum, and the marl. The saline deposit does not consist exclusively of common salt, and may be divided into four chief regions. The lowest bed is the largest, and consists entirely of rock-salt traversed by slender veins of karstenite. It is about 240 metres in thickness. We find next the region of polyhalite, still composed of rock-salt, but intersected by veins of 2 to 3 c.m. thick, formed of polyhalite, a mineral composed of sulphates of lime, magnesia, and potash, agreeing with the formula—

$$2(CaO,SO_3)+MgO,SO_3+KO,SO_3+2HO.^1$$

This layer is about 64 metres in thickness, and is composed on an average of 91·2 per cent. chloride of sodium, 0·66 of karstenite, 6·63 of polyhalite, and 1·51 of hydrated chloride of magnesium. To this stratum succeeds another, of a different composition, and characterized by the presence of a saline mineral named kieserite. It consisted of mono-hydrated sulphate of magnesia, in small microscopic needles. The layer contains 65 per cent. chloride of sodium, 17 of kieserite, 13 of carnallite (see below), 3 chloride of magnesium, and 2 of karstenite. Its thickness is 56 metres. The upper region is formed of a group of salts chiefly magnesic and potassic, and formerly called *riddance* salts, because they were at first without industrial application, and were merely extracted to reach the rock-salt below. These salts are now the foundation of the trade of Stassfurt. The principal salt is carnallite, a chloride of potassium and magnesium,—

$$KCl+2MgCl+12HO.$$

It has a red colour, due to the presence of oxide of iron in microscopic lamellæ. There are found also, in this deposit, Sylvine or Howellite, a chloride of potassium often containing small quantities of sulphate of potash, and of sulphate and chloride of magnesium; Tachyhydrite, a carnallite in which the chloride of potassium is replaced by chloride of calcium; and Boracite, a combination of the borate and chloride of magnesium,—

$$(6MgO,8BO_3+MgCl).$$

Stassfurt, as above stated, lies on the Prussian frontier, towards the borders of the duchy of Anhalt. The Prussian workings, therefore, could not be extended to the south-west, where the geological conditions were most favourable. In 1855 the government of Anhalt commenced operations within its own territory, with perfect success. The saline beds were reached at the depth of 145 metres, and soon a new salt was discovered in great quantity, giving a new impulse to the trade of the district. This is kainite, a compound of sulphate and chloride of magnesium. Its discovery enabled the inhabitants to enter upon the manufacture of pure sulphate of potash, which is largely exported to England and the United States. The model of purification of the crude salts obtained from the mines is described at some length. Their applications are numerous. The chloride of potassium is used in the manufacture of saltpetre and carbonate of potash; the sulphate of potash is in great demand in the glass and alum works. Stassfurt exports, also, sulphate of magnesia, chloride of magnesium,—which is extensively used in England for the discreditable purpose of adding to the weight of textile goods, and rendering them hygroscopic,—bromine to an extent almost sufficient for the consumption of Europe, and boracic acid. Lastly, the impure salts obtained as waste in the various refining processes—consisting principally of salts of soda, magnesia, and potash—are skilfully combined, and sold as mineral manures, more or less rich in potash and magnesia. The demand for these manures has greatly increased of late years, especially in England and Germany. In 1869 the Prussian mine alone yielded 109,075,000 kilos. of potash-salts, and 56,332,000 kilos. of rock-salt, representing a total value of 916,960 francs. *Dingler's Polyt. Jour. cciii.* 194.

[1] Old notation used throughout.

§ 2. *Metallurgy.*

Process for Heating the Blast for Iron and other Furnaces.—The "Société Métallurgique pour l'Exploitation des Procédés Ponsard" patents a system of heating the blast, consisting of a Ponsard regenerator, by which part of the blast at a low pressure is heated, and then mixed with the rest of the blast at a higher pressure. Or the regenerator may be used thus: air at the same pressure is blown into both parts of the regenerator, *i. e.* into the portion where the combustible gases from the furnace top are burnt, and into the portion used for heating the blast; the pressures being equal, there is no great danger of leakage of air or gases through the joints in the brick walls. *Bulletin Soc. Chim. Paris, xx.* 141.

Apparatus for Puddling and Melting Cast-iron.—POST patents the use of a hemispherical basin built inside a reverberatory furnace, and capable of turning round an axis inclined at about 30° to the vertical, so as to produce mechanical puddling. *Bulletin Soc. Chim. Paris, xx.* 141.

Direct Puddling from the Ore.—MARTIN patents the use of the following process:—The pulverized ore is mixed with 25 to 50 per cent. of carbon (wood charcoal, anthracite, coke, &c.), and placed in a tube heated by the waste heat from a puddling furnace; when the reduction to metal is complete the mass is raked into the hearth of the puddling furnace, where it rapidly "comes to nature," and is made into balls in the usual way. Most of the sulphur and phosphorus in the ore is thus eliminated; by the addition of various mixtures this elimination may be made more complete. *Bulletin Soc. Chim. Paris, xx.* 143.

Steel Making.—SHEEHAN patents the heating of the malleable iron with a mixture of wood charcoal, black oxide of manganese, and black resin, so as to transform the surface into steel without altering the shape of the objects thus aciérated. *Bulletin Soc. Chim. Paris, xx.* 141.

Welding Steel.—BROOKS patents the manufacture of welding steel by melting in a crucible—

Bar iron	34·	kilogrammes.
Tungsten	0·400	„
Wood charcoal	0·230	„
Manganese	0·085	„
Fluor spar	0·230	„

A finer quality is obtained if 0·070 kilog. of tungstate of calcium be substituted for the tungsten in the above formula; the product welds without any flux or other treatment.

The following mixture is used for iron plates (fer à lames):—

Bessemer rail	34·	kilogrammes.
Cast-iron	0·032	„
Fluor spar	0·056	„
Manganese	0·015	„
Wood charcoal	0·032	„
Bismuth	0·028	„

Bulletin Soc. Chim. Paris, xx. 142.

Hardening Steel Surfaces.—AMES patents the use of friction against a rapidly moving surface for the purpose of communicating great hardness to the surface of steel; the hardness superficially communicated exceeds that produced by the ordinary process of hardening at a white heat. To produce this result, an emery wheel 25 centimetres diameter, and making at least 1,800 turns per minute, is employed, the steel being thus hardened to the depth of 0·8 millimetre.—*Bulletin Soc. Chim. Paris, xx.* 143.

Scale of Colours for Tempering Steel.—HARTLEY patented in 1789 the following scale:—

430° Fahrenheit	= 221° Centigrade.		Very pale yellow, suitable for lancets.
450°	„ = 232°	„	Straw yellow, for surgical instruments and razors.
470°	„ = 243°	„	Bright yellow, for pen-knives.
490°	„ = 254°	„	Brown, for chisels and tools for cutting iron.
510°	„ = 265°	„	Brown with purple spots, for axles and planing irons.
530°	„ = 277°	„	Purple, for table knives and large chisels.
550°	„ = 288°	„	Clear blue, for swords, watch-springs, and clock-springs.
560°	„ = 293°	„	Deep blue, for fine saws, poignard blades, &c.
600°	„ = 315°	„	Nearly black-blue, for hand-saws.

This last gives the softest temper, and is only suitable for saws which must not be too hard, otherwise they could not be set and sharpened with a file. *Les Mondes, xxxi.* 637.

Phosphorus in Iron Ore.—I. L. BELL states that 30,000 tons of phosphorus are annually sent away in the iron of the Cleveland district alone. If this were converted into phosphoric acid it would be worth £250,000 per annum as manure. Remaining in the iron as it does, it depreciates its value to the extent of £4,000,000 as compared with the same amount of hæmatite iron. This estimate refers to the produce of one district alone. The aggregate saving would be of course vastly greater. Consequently there is a wide field for chemical ingenuity in endeavouring to discover a method whereby the phosphorus can be successfully eliminated from the pig-iron, and made into valuable manures. *Chemistry of the Blast Furnace, by I. Lowthian Bell.*

Analysis of Liquids containing Iron.—CHARPENTIER employs an alkaline solution of known strength, previously adding some sulphocyanide of potassium to the solution to be tested; theb lood red colour of the sulphocyanide of iron formed is discharged, when a quantity of alkali is added equivalent to the peroxide of iron present (the solution being of course exempt from all free acid). *Revue Universelle des Mines, March*, 1873.

Native Compound of Oxides of Iron and Copper.—C. FRIEDEL gives the following analysis of a new mineral (Delafossite) found at Katharinenberg, Perm, Russia :—

Sesquioxide of iron	47·99
Alumina	3·52
Suboxide of copper	47·45
	98·96

Its hardness is 2·5, and its specific gravity 5·07; it is opaque even in thin laminæ, and yields a black powder. It is found accompanying laminary graphite. *Comptes Rendus, July 21st*, 1873.

Purification of Iron and Copper.—ZENGER patents the use of alkaline or earthy hydrates to re-act on the fused metal out of contact with air. The molten metal is covered with a layer of charcoal 5 centimetres thick; this is gently blown with a bellows with a blast of $\frac{1}{8}$ or $\frac{1}{10}$ atmosphere, so as to produce carbon oxide; three parts of lime and one of sawdust or tar are added, and the whole stirred; a red scoria containing much sulphur and phosphorus is produced, the hydrate disappearing. As much mixture is used as represents 1 per cent. of the phosphorus contained in the cast-iron, &c., or 0·5 per cent. of the sulphur. Perfect purification ensues (?); the purified metal can be puddled or subjected to the Bessemer process.

In the same way copper can be purified from phosphorus, arsenic, or antimony. *Bulletin Soc. Chim. Paris, xx.* 140.

Arsenide of Copper.—FRENZEL finds the following composition of a specimen of arsenide of copper from Copiapo, Chili :—

Specific gravity	6·700
Copper	70·16
Arsenic	25·89
Iron and manganese	3·50
Sulphur	0·49
Residue	0·45
	100·49

Another specimen from Lake Superior contained :—

Copper	72·02
Arsenic	28·29
	100·31

whilst one from Cerro las Paracutas, Cigazuala, Mexico, contained :—

Copper	72·99
Arsenic	27·10
	100·09

These were somewhat heavier, having respectively the specific gravities 7·207 and 7·547. *Jahrbuch für Mineralogie*, 1873, 26.

WASBACH also finds an analogous mineral imbedded in argillaceous porphyry at Mulde, near Zwickau; the specific gravity of this is 6·84. *Ibid. p.* 64.

Arsenic Glauce.—A mineral has been described under this name by KERSTEN, containing :—

Arsenic	97·00
Bismuth	3·00
	100·00

This has the specific gravity 5·3, whilst the constituents have higher densities, viz., arsenic 5·7, bismuth 9·7.

The same name has also been given to a mineral which contains :—

Arsenic	92·80
Antimony	2·28
Iron	1·60
Nickel	0·26
Sulphur	1·06
	98·00

This appears to be only impure metallic arsenic, whilst the former mineral is probably a definite compound. *Jahrbuch für Mineralogie*, 1873, 25.

Detection of Arsenic.—GATEHOUSE modifies Fleitmann's test thus : the substance to be tested is heated gently in a long test tube with aluminum foil and a lump of caustic soda; arsenuretted hydrogen is evolved, which is recognized by covering the mouth of the tube with filter-paper moistened with silver-nitrate solution; a brown stain is thus produced even with minute quantities of arsenic. Antimony does not yield this reaction. *Chemical News, xxvii.* 189.

New Vanadium Ores.—A. V. LASAULX describes a new mineral, ardennite, found near Ottrez in the Belgian Ardennes, the composition of which is—

Silica	29·74
Alumina	23·50
Peroxide of iron	1·94
Protoxide of manganese	25·96
Lime	2·04
Magnesia	3·42
Pentoxide of vanadium	9·10
Phosphoric acid	trace
Copper	trace
Water	4·04
	99·74
Specific gravity	3·620

Pisani has analyzed a similar mineral, dewalquite, from Salm-Château, Belgium. This is essentially the same as the preceding, but contains less vanadium. *Jahrbuch für Mineralogie*, 1872, 930, *and* 1873, 124.

Action of Hydrogen Gas on Solutions of Platinum and Silver Salts.—MERGET finds that *pure* hydrogen gas does not reduce solutions of silver salts nor of platinum salts; on the other hand, the presence of a minute quantity of arsenuretted hydrogen in the gas causes reduction with ease. *Comptes Rendus, July* 14, 1873.

Brittle Gold.—W. C. ROBERTS states that Miller's process for toughening brittle gold by passing chlorine through the molten metal is the most effectual method yet devised. During the year 1872 only 17,000 oz. of gold required to be set aside as unfit for working, whilst in the previous year the quantity amounted to 40,000 oz. *Third Annual Report of the Deputy Master of the Mint*, 1872.

Lead; its Impurities, and their Influence on the Technical Use of the Metal.—Impure lead is usually somewhat whiter and less soft than pure lead, which readily stains the hands, linen, &c. Sulphur, iron, tin, antimony, and copper are the usual impurities, and are injurious for many technical applications, especially white-lead making. Pure lead melts at 330° to 335°; at a little below the melting-point it is brittle; at a white heat it is volatile in closed vessels. *Ber. D. Chem. Ges. vi.* 191.

Tinning, &c. of Brass, Copper, Iron, &c. in the Wet way.—C. PAUL describes the following method: The zinc or iron articles are immersed in a mixture of one part of sulphuric or nitric acid with ten parts of water, and then a solution of copper sulphate or acetate is slowly added. After the deposition of a thin layer of copper, the articles are removed, washed, moistened with a solution of one part of "tin crystals" in two parts of water and two parts of hydrochloric acid, and then shaken up with a mixture of fine chalk and copper-ammonium sulphate, which is prepared by dissolving one part of copper sulphate in sixteen parts of water and adding ammonia until a clear dark-blue liquid is obtained.

The articles may now be tinned by immersion in a solution of one part tin crystals with three parts white argol in water. Brass, copper, or nickel goods, also iron and zinc articles which have been copper-plated, may be silvered by treatment—after previous cleansing—with a solution of 14 grams of silver in 26 grams of nitric acid, to which is added a solution of 120 grams of potassium cyanide in one litre of water, and also 28 grams finely-powdered chalk.

Some further directions for producing shades of colour on the silvered articles are given in the original paper. *Bayer. Industrie- und Gew.-Blatt*, 1873, 91.

Alloys used for Gold Coinage.—E. PELIGOT discusses the question as to the establishment of simple relations between the system of weights founded on the metre as starting point, and the gold coinage of France. In order that a simple relation should exist, either the weight, the standard, or the value of the chief gold coin must be altered: taking a standard of nine-tenths (that adopted by many nations—England excepted), the 20-franc piece weighs 6·451 grammes: a piece weighing 10 grammes would be worth 31 francs. Now it would be inconvenient to alter the value of the chief gold coin to any quantity which was otherwise than simply related to the present 20-franc piece; but by suitably modifying the standard it would be easy to make a coin weighing a certain number of grammes, 10 say, which should be worth a given number of francs, 20 say.

If an alloy were adopted the kilogramme of which were worth 3,000 francs, the standard would be 871 thousandths, which is exactly the standard of the old "ounces" of Naples, the "sequins" of Tunis, and the "ducats" of Denmark. Such an alloy therefore would posses the necessary mechanical properties desirable for coinage, experience being the proof thereof: on the other hand subdivision of a coin of 10 grammes worth 30 francs would be somewhat inconvenient.

This objection would not apply to a standard of 725 thousandths, representing (with the cost of fabrication) a value of 2,500 francs per kilogramme; a 25-franc piece would weigh 10 grammes, a 20-franc piece 8 grammes, a 5-franc piece 2 grammes with this standard: the mechanical properties of an alloy of gold and copper of this standard, however, would not be suitable for coinage, such an alloy being too hard and too little malleable to be easily worked; but if 100 or 125 thousandths of silver replaced as much copper in the alloy, a substance closely approaching in composition to French jewellery (750 thousandths) would result, and this would possess good coining qualities. Taking into consideration the value of the silver, this alloy would have a gold standard of about 720 thousandths.

Metal at 2,000 francs the kilogramme would have a standard of 580 thousandths, 6·57 francs being allowed for cost of fabrication (i.e. a kilogramme of gold alloy at 580 thousandths would be worth 1,993·43 francs). This standard is about 14 carats English, and the metal would consequently be mechanically suitable for coinage: it gives a very simple relation between weight and value.

A 20 franc piece weighs 10 grammes.
„ 10 „ „ 5 „
„ 5 „ „ 2·5 „
1000 francs weigh 0·5 kilogramme.

and hence the gold and silver coins would be very simply related.

10 grammes of gold coins would be worth 100 of silver coin.
1 „ „ „ 10 „

The author has experimented with various alloys of this standard, and finds that tertiary alloys of gold, copper, and zinc, containing 50 to 70 thousandths of zinc, possess a good colour and sufficient malleability for coinage, whilst they do not tarnish more rapidly than the gold alloy in actual use, especially when "coloured" (*i.e.* treated with an agent which superficially extracts the baser metals, leaving a thin film of pure gold on the surface). In order to form these alloys, the zinc may be added in the form of ordinary brass, but as commercial brass often contains lead which would damage the alloy, a specially prepared copper-zinc alloy of known composition would be preferable. The loss of zinc by volatilization is practically unappreciable, a weight of ingot being obtained almost exactly equal to the weight of metals used.

The following four alloys have been more specially studied:

	1	2	3	4
Gold	580	581	580	580
Copper	354	362	372	360
Zinc	66	57	48	60
	1,000	1,000	1,000	1,000

No. 3 is notably more red than No. 1, even though the latter contains less than 2 per cent. more zinc.

With a higher proportion of zinc, up to 100 or 110 thousandths, a brittle alloy is obtained with a greenish-yellow hue. In fine, the author sums up the advantages to be derived from the adoption of the standard he more specially recommends (580 thousandths) as follows:—

1. The weight, being decimal, brings coinage into relation with the metrical system.
2. The bulk of coins being notably increased, the convenience attaching to the smaller denominations of gold coins is much greater. Thus five-franc pieces are much in request; yet a silver five-franc piece is inconveniently large, whilst the gold five-franc piece is too small.
3. Re-coinage of existing money would be unnecessary; the present coins could circulate with the new ones without any confusion, the new issue being simply made thicker.
4. With equal surface and hardness the larger mass of metal would cause less loss proportionately by wear and tear.
5. Being dissimilar from all other money in circulation, national susceptibilities would not be wounded, as is apt to be the case in any scheme for monetary unification. *Revue Scientifique, August 9th*, 1873, *p.* 139.

§ 3. *Dycing, Calico Printing, Bleaching, and allied subjects.*

New Dye Isomeric with Alizarin.—F. GRIMM describes a substance which much resembles alizarin, formed by heating together hydroquinine and phthalic acid: this body is only formed in small quantities, 1 or 2 per cent. of the theoretical yield only being obtained. It appears to be intimately connected with alizarin, yielding anthracene on heating with zinc dust, and forming lakes, and dying mordanted goods, in much the same way, though with different shades. Not improbably this substance may turn out to be one of the constituents of the products known as "artificial alizarin;" it differs from alizarin in melting point and other physical properties, in the colours of its lakes, and in giving solutions which possess a bright green-yellow fluorescence (alizarin solutions are non-fluorescent), and which yield absorption-spectra different from those of alizarin itself: the author gives a table of the comparative absorption-spectra furnished by solutions of this new body and of alizarin, the solvents being caustic soda, carbonate of potash, ether, and sulphuric acid. To distinguish it from its isomeride alizarin, and to indicate its character and origin, the author applies the term *quinizarin* to the new product. *Berichte der Deut. Chem. Ges. vi.* 506.

Valuation of Aniline Dyes.—STAMM proposes to value these colours by means of a solution of hydrosulphite of sodium (the product of the action of zinc on sodium acid sulphite, more properly termed *hypo-sulphite*, being indicated by the formula NaH,SO_2). Rosaniline is decolorized by this agent in the cold; other aniline colours require to be heated to boiling. By noting the relative quantities requisite to decolorize the substance examined, and a pure specimen, the value of the dye may be estimated.

The determination must be performed in an atmosphere of carbonic acid: each molecule of dye material corresponds to as much hydrosulphite as could decolorize two molecules of ammoniacal copper sulphate. *Bulletin Soc. Chim. Paris, xx.* 124.

Natural-coloured Silk.—RUIMET DES TAILLIS states that cocoons of a magnificent red tinge may be produced by feeding silkworms on vine leaves, whilst a deep emerald green tinge is produced by lettuce leaves.

Delidon de Saint-Gilles has obtained a beautiful yellow silk by feeding the silkworms on lettuce or white nettle, other specimens being green and others violet. During the earliest portion of the larva stage the silkworm should be fed on mulberry leaves; during the last twenty days on vine, lettuce, or nettle leaves. *Les Mondes, July* 10, 1873.

Tanning Skins.—ALIMONDA patents an apparatus for forcing tan liquors into the pores of skins under great pressure (several atmospheres) obtained by means of a pump. *Bulletin Soc. Chim. Paris, xx.* 139.

Utilization of Old Dye-Liquors.—As a means of extracting from such liquors everything of value, it is proposed that the bath in which scarlet has been dyed should be gradually exhausted by dyeing with it successively lighter and lighter shades. A better proposal is, where practicable, to keep one and the same bath for the same colour. *Reimann's Färb.-Zeit.* 1873, *No.* 25.

On Aniline Greens.—LAUTH and BAUBIGNY propose to replace the iodide of methyl, in the manufacture of certain aniline colours, by an ether with a mineral acid, a sulphate, hydrochlorate, nitrate or phosphate, or by the sulpho-conjugated acids of the alcoholic radicals. The best results have been obtained with nitrate of methyl in presence of an alkali or alkaline earth. The energetic action of this ether renders it practicable to operate at low temperatures, either in open or closed vessels.

Quantitative Examination of Iron Mordants.—H. VOHL advises the following method. If the mordant in question contains chlorine, it is precipitated by means of sulphate of silver, and the chloride of silver obtained is weighed. To determine nitrous and nitric acids, the filtrate is precipitated with baryta. The sulphuric acid and the oxides of iron are precipitated, whilst the filtrate, after prolonged digestion at a gentle heat, contains the nitric and nitrous acids in the state of barytic salts. The precipitate is well washed in boiling water, and the excess of baryta is removed by means of a current of carbonic acid gas. The whole filtrate, with the washings, is brought to a definite volume, say 100 cc. The presence or absence of nitrous acid is ascertained by means of the ordinary tests. Then the amount of baryta contained in 5 or 10 cc. of the liquid is determined, either volumetrically or gravimetrically. If no nitrous acid is present, the whole of the baryta present in solution corresponds to the nitric acid, which is thus determined indirectly. If both nitrite and nitrate are present, a known volume is evaporated to dryness, and the residue is taken up in absolute alcohol, which dissolves the nitrite only, leaving the nitrate untouched. The determination of the baryta in each of these salts gives the respective amounts of nitrous and nitric acids. To determine the ferrous oxide in the mordant, it is diluted with water, and digested in the cold with carbonate of lime in a flask filled with carbonic acid. When the liquid has grown clear, it is filtered in a current of carbonic acid and washed in distilled water. The solution containing the ferrous salt is then oxidized with chlorate of potassa and hydrochloric acid, and the ferric oxide thus obtained is precipitated with ammonia. The presence in a mordant of a ferrous salt and of nitrous and nitric acids is in general injurious.—*Musterzeit. xxii.* 2.

[*Note by Abstractor.*—The process is hardly commendable for practical purposes, being rather too complicated. As to the injurious effects of a ferrous salt when present in a mordant, this appears by no means so certain as the author states.—R. G.]

On the Colouring Matter of Madder-Root and its Artificial Formation.—That a certain colouring matter could be obtained from the roots of the *rubia tinctorum* has been known from immemorial antiquity, and at the present day it is familiar to all as the commonest dye applied to calicoes. The madder now used in England is imported from France, Italy, Holland, South Germany, Turkey, and India; in 1857 the total amount imported was 434,056 cwt., valued at £1,284,989, but in 1872 it fell to 283,274, valued at £922,244. The magnitude of the industry is therefore obvious. To obtain the colouring matter, which is but sparingly soluble in water, the roots are ground, mixed with water and sometimes a little chalk in the dye vessel, the material to be dyed is introduced, and the colouring matter slowly passes from the water into the mordanted fabric, giving it a colour dependent, of course, on the nature of the mordant. To trace the history of the colouring matter, one must go back to the year 1790, when a chemist named Watt obtained from the roots two kinds of colouring matter, but could not isolate them; little real advance was made in our knowledge of the chemical constitution of the colouring matter until 1827, when Colin and Robiquet obtained the true colouring principle in a state of tolerable purity. They named it alizarin, from the Levant name for madder. Schunck confirmed the existence of alizarin in the madder root; he also discovered the explanation of the curious phenomenon that the whole of the tinctorial power is developed after the death of the plant; his explanation being that the root contains a substance called rubian, which, by treatment with sulphuric or hydrochloric acid, is converted into alizarin and sugar; the root also contains a substance which, in time, produces spontaneously exactly the same effect as these acids on the rubian. This fact explains the circumstance so well known to dyers, that madder will for years go on improving in quality, the rubian becoming gradually more completely converted into colouring matter. It thus appears that there are two substances in the plant kept apart during its vitality by processes of which we know nothing, but after its death beginning slowly to act on one another. The last investigation of interest into alizarin as obtained from the madder root was published by Julius Wolff and Adolf Strecker in 1850. They suggested the theory that chlorophthalic acid (obtained from naphthalene by acting on it with chlorine and nitric acid) is a substance only differing from alizarin in that it contains two atoms of chlorine in place of two of hydrogen. The substitution of hydrogen for chlorine, however, has never been effected, and it is now known that even if it could be effected the result would not be alizarin, but a different, though analogous substance. Our present knowledge comes from the careful study of abstract chemistry—a study whose advantages are shown by nothing in the history of chemistry more than by the history of alizarin. In 1835, Alexander Woskrensky, of St. Petersburg, made, at the suggestion of Liebig, some investigation into the formula for quinic acid, an acid obtained from cinchona bark. In the course of these investigations he obtained a peculiar new substance called quinone. For a long time the definite place of this substance amongst chemical compounds was not known. In 1868, however, Carl Graebe published a paper suggesting its relation to the hydro-carbon benzol. This suggestion was the key to the matter. It was speedily discovered that quinone was not, as had been imagined, an isolated substance, but was connected with a wide group of naphthalene derivatives. Further investigation at last led to the discovery that alizarin itself is a derivation from a quinone. By heating alizarin with zinc powder there is obtained the well-known hydro-carbon—anthracene; and from anthracene a quinone can be formed. Now, by analogy with the properties of other quinones it was judged that the process could be reversed, and alizarin formed from anthracene. This was accomplished, and thus an artificial method of forming alizarin was discovered. A special interest will always attach itself to the discovery, it being the first instance in which a natural organic colouring matter has been artificially formed. Although the first, it is a safe prediction that it will not long be the only one. Sooner or later that most interesting dye, scientifically and practically, indigo, will yield to the scientific chemist the history of its production. Experiments carried out chiefly by Perkin, have solved the problem of the production of alizarin on a manufacturing scale, and the demand for artificial alizarin is rapidly increasing. Last year one-fifth of the alizarin used in the country was artificial, and this year the amount will be much larger. Thus is growing up a great industry, which, far and wide, must exercise most important effects. Old and cumbrous processes must give way to better, cheaper, newer ones, and thousands of acres of land in many different parts of the world will be relieved from the necessity of growing madder, and be ready to receive some new crop. In this sense the theoretical chemist may be said even to have increased the boundaries of the globe. *From Dr. Russell's Inaugural Address to the Chemical Section at the British Association, Bradford.*

§ 4. *Food and Sanitary Matters.*

Concentration of Wines by Freezing (Turbinage).—MELSENS finds that when ice is formed in alcoholic liquids by freezing them, such ice does not contain any alcohol, the whole of this substance present being contained in the unfrozen portions. In order to remove the ice from wine treated in this way, the drainer (turbine) of the sugar refinery affords the most convenient means. *Comptes Rendus, July* 14, 1873.

Beer from Beetroot Juice, &c.—LALONEL DE SOURDEVAL patents the treatment with superphosphate of lime of beetroot juice, and the juice of sorgho and other saccharíferous plants, as a preliminary to their use for brewing beer, either alone or admixed with the ordinary worts. *Bulletin Soc. Chim. Paris, xx.* 139.

Raw Sugars of the Third Produce.—VIOLETTE draws the following conclusions from his observations and analyses :—

1. The sugar of the third produce from the north of France contains most of the mineral and organic matters of the molasses from which they are derived.

2. Molasses exceptionally rich in chloride of potassium furnish sugars containing large quantities (as much as 36 per cent.) of a compound of sugar and potassium chloride, which crystallizes in the same shape as sugar, and cannot be distinguished from it by the appearance only.

3. The ordinary mode of estimating the ash, viz., incinerating with addition of sulphuric acid, and deducting 1-10th of the weight of the residue, gives too high a result if much soda or other alkaline salt be present.

(Thus, an average specimen gave 3·78 per cent of sulphated ash, 9-10ths of which would be 3·41 per cent. of ash ; the quantity found by direct incineration, however, was only 3·118 per cent.)

4. The ash from sugars of the third produce is about three quarters of the total weight of salts existing in these sugars. *Comptes Rendus*, 76, 642.

New Saccharimeter.—PRAZMOWSKI describes a new optical contrivance consisting of a thick plate of calcite cut parallel to its axis and divided through the axis, the halves being reunited after removal of a small angle (about 2°) from each, so that the principal sections are inclined to each other at an angle of 4° ; this enables slight differences of intensity to be appreciated more readily. Mono-chromatic light is necessary with sugar, otherwise the two halves are differently coloured. *Comptes Rendus*, 76, 1212.

Manufacture of Gelatine.—HEUZE obtains gelatine of good quality from even inferior sources, such as the substances obtained during the manufacture of neat's-foot oil. The gelatine from this source is very dark, and hence has only a limited sale at the low rate of 42 francs the 100 kilos. By digesting for three hours at a pressure of three atmospheres, pouring off the resulting ammoniacal solution of gelatine, separating the supernatant oil, and evaporating, a black friable gelatine results. Attempts to bleach this by sulphurous acid, or a sulphite, and hydrochloric acid, gave unsatisfactory results. If the digestion, however, be continued for only one hour, and the liquid be then run off, a second digestion for an hour following with fresh water, and after pouring off the second liquors, a third for another hour, a much better result is obtained, the liquids resulting being almost perfectly decolorized by treatment with 4 per cent. of charcoal mixture, consisting of wood charcoal 100 parts, animal charcoal 25 parts. The gelatine thus obtained can be used for food, as it has no smell, and has only a slight yellow tint when seen in large masses. *Dingler's Polytech. Journal*, 207, 506.

Composition of Human Milk.—T. BRUNNER describes his method of examination, which he considers superior in several respects to those in ordinary use. The mean composition was found to be :—

Albuminoids	0·63
Fat	1·73
Sugar	6·23
Water	90·00
Soluble salts, extractive matter	1·41
	100·00

Pflüger's Archiv. Physiologie. vii. 440.

Waters of Vichy.—GOUVENAIN finds that Vichy waters contain sufficient iodine and bromine to be perceptible on concentration of the water. Thus the following quantities of bromine, iodine, and fluorine, per litre of water were obtained :—

	Bromine	Iodine.	Fluorine.
Grand-Grille	0·0008 grammes	trace	0·0076
Vichy	trace	trace	0,583
Bourbon l'Archambault	0·00684 grammes	trace	0·00268
Néris	trace	trace	0·00614

Boron, arsenic, lead, copper, rubidium, cæsium, and nitric acid, were found in the mother-liquors of the Grand-Grille water ; and arsenic, lead, copper, cobalt, zinc, aluminium, and manganese in its calcareous deposit. *Comptes Rendus*, 76, 1063.

Sulphuretted Springs of Sta. Venere al Pozzo (eastern side of base of Etna).—P. SILVESTRI gives the following analysis :—

Specific gravity at 19°	1·002836
Hardness	46°
Gaseous matter evolved in boiling	0·23450
Consisting of :—	
Sulphuretted hydrogen	0·01547
Carbonic acid	0·18453
Marsh gas	0·00757
Oxygen	0·00017
Nitrogen	0·02676
Carbonic acid of neutral carbonates of calcium, magnesium, and strontium	0·05480
Lime	0·07300
Magnesia	0·00698
Sodium	1·07521
Potassium	0·00035
Lithium	0·00120
Ammonium	0·00021
Manganese	0·00020
Iron	trace
Anhydrous sulphuric acid	0·04037
Chlorine	1·64809
Bromine	trace
Iodine	0·01250
Fluorine	trace
Silica	0·00050
Organic matter	0·02880
Aluminium phosphate	0·00050

Gazzetta Chimica Italiana, iii. 35.

Action of a Mineral Sulphurized Water on a Cast-iron Pipe.—PRIWOZNIK finds that the innermost layer of a cast-iron pipe that had been exposed for twelve years to the action of water containing much sulphuretted hydrogen had the following composition :—

Hydrated oxide of iron	81·08
Free sulphur	12·29
Sulphide of iron	4·48
Hygroscopic water	0·57
Nickel, cobalt, magnesia, silica, chloride of ammonium, chloride of sodium	1·58
Carbon	trace
	100·00

The middle stratum contained 79·2 per cent. of metallic iron, the outer layer 92·6 per cent. *Annalen der Chem. und Pharm. clxviii.* 126.

Water-drinking for Animals.—HENNEBURG finds that the more water is given to cattle as a beverage, the more is given off through the skin and lungs, whilst a less quantity of the carbohydrates contained in the food is assimilated, more nitrogen being contained in the urine. Consequently, it is not desirable to keep animals that are to be fattened in hot stalls, nor to give them much water to drink. *Dingler's Polytech. Journal*, 207, 431.

Vitality of Vegetables.—CH. BLONDEAU gives a detailed account of the effects of heat and electricity on various plants and seeds, their growth, germination, &c., &c., from which it appears that some plants are much more sensitive to such influences than is commonly supposed. *Moniteur Scientifique Quesneville, Aug.* 1873, *p.* 732.

Nitrification in Soils.—TH. SCHLOESING finds that the amount of nitrate formed increases with the quantity of oxygen in the gas to which the soil is subjected up to 16 per cent. of oxygen ; but when the oxygen forms more than this proportion, the amount of nitrate produced is lessened. When only 1½ per cent. of oxygen is present there is still much nitrate formed ; apparently the nitrogen in the air takes part in the production of nitrates. The author employed a soil containing much lime and humus, and eliminated all ammonia and carbonic acid from the air used. *Comptes Rendus, July 21st*, 1873.

Value of Excreta in France.—GRANDEAU calculates from the official statistics the average quantities of nitrogen, phosphoric acid, and potash excreted by each kind of animal, and the following values for the total manure produced annually in France :

		Francs.	Francs.
Population	36 millions at	15·13 =	544,680,000
Oxen	10 „	181·94 =	1,819,400,000
Horses	3 „	132·74 =	398,200,000
Sheep	35 „	15·38 =	538,300,000
Pigs	6 „	23·55 =	141,300,000
			3,441,900,000

or, £137,000,000 sterling.

The total nitrogen contained in these excrements amounts to 1,141,950,000 kilogrammes (about 1,142,000 tons). *Les Mondes*, *xxxi.* 643.

Influence of Manures on Weeds.—R. HEINRICHS manured soil with the following manures, and found the annexed percentages of weeds in red clover crops grown on the soil :—

Without manure	Weeds 57	per cent.
Ammonium sulphate	„ 30	„
Sodium nitrate	„ 26	„
Sulphuric acid	„ 18	„
Magnesium sulphate	„ 10	„
Sodium chloride	„ 7	„
Potassium sulphate	„ 5·5	„
Calcium carbonate	„ 4·9	„
Quicklime	„ 4·5	„
Superphosphate	„ 4·4	„
Gypsum	„ 1·9	„

Calcareous manures, gypsum especially, appear to exert a special influence on the clover crop, greatly increasing it, but not influencing the weeds to the same extent. *Dingler's Polytech. Journal*, 207, 431.

Physiological action of Nitrous Oxide.—JOLYET and BLANCHE conclude from their experiments that pure nitrous oxide cannot maintain respiration either in plants or animals. Seeds will not germinate in an atmosphere of the gas. *Comptes Rendus*, *July* 7, 1873.

Brittleness of Bones in Cattle.—NESSLER finds that when unusual brittleness is noticeable in the bones of horned cattle proteine bodies are usually deficient in the hay and fodder, and sodium is also present only in small quantity. A variety of hay specially apt to produce this peculiarity was very poor in phosphoric acid and lime salts, and the water drunk by the cattle affected contained but little mineral matter. *Annalen der Landwirthschaft*, 1873, 126.

Digestion in Birds.—JOBERT finds that the gizzard possesses actual digestive powers, inasmuch as it secretes a kind of gastric fluid ; although it triturates the food, this is not its sole function. *Comptes Rendus*, *July* 14, 1873.

Incremation.—An anonymous writer strongly advocates incremation as opposed to burial, stating that in Belgium alone 7,500 hectares (18,000 acres) of land are rendered unproductive, being used as cemeteries. *Annali de Chimica applicata alla Medicina. June*, 1873.

The Water of a Salt Spring at Huel Seaton Mine.—J. A. PHILLIPS publishes the following notes on this subject :—Huel Seaton copper mine is situated about one mile north-east of the town of Camborne, in Cornwall, and about three miles from the sea. The workings of the mine are entirely in "killas," or clay-slate, and the saline waters issue at the rate of 50 gallons per minute, and at a temperature of 27° C. (about 90° F.), from the eastern fore-breast of the 160-fathom level. This intersects a fault, or cross-course, which runs in a northerly direction to the sea. The temperature of the level from the end of which the water issues, like that of the water itself, is 27° C. The following figures were obtained by analysis : specific gravity, 1·0123 ; total solid contents, 1005·61 grains per gallon.

	Grains per gallon.
Carbonic acid	5·56
Sulphuric acid	1·25
Silica	1·89
Chlorine	642·10
Bromine	trace
Alumina	24·19
Ferric oxide	0·22
Manganese	trace
Copper	minute trace
Lime	243·56
Magnesia	5·05
Alkaline chlorides	454·44
Potassium	5·82
Cæsium	trace
Sodium	160·84
Lithium	5·63
Ammonia	trace
Nitric acid	trace

These figures may be put into the following combinations :—

	Grains per gallon.
Calcic carbonate	6·45
Ferrous carbonate	0·31
Manganous carbonate	trace
Cupric chloride	minute trace
Calcic chloride	473·81
Magnesic chloride	11·98
Aluminic chloride	63·02
Potassic chloride	6·43
Cæsic chloride	trace
Sodic chloride	409·09
Lithic chloride	34·22
Calcic sulphate	2·12
Potassic bromide	trace
Potassic silicate	4·85
Nitric acid	trace
Ammonia	trace
Total found by addition of constituents	1012·35
Total found directly	1005·61
Free carbonic acid	2·61

The difference between the total found directly, and that obtained by adding the constituents, is probably in great measure due to the partial decomposition of aluminic and magnesic chlorides at the temperature 180° C., at which the drying of the residue was effected.

A consideration of the various phenomena connected with the occurrence of this and other seemingly like springs which have at different times been discovered in the same district would indicate that they all have more or less direct communication with the sea, and that they are either the result of infiltration of sea-water through faults, or are true and independent sources, which, being tapped below the sea level, have found their way to the ocean through faults or channels. The following is not an improbable explanation of the origin of the spring. The cross course is thought to extend through both granite and clay-slate to the sea. From the close contact of its surfaces, the presence of clay, and from other causes, this fault may be supposed not to be uniformly permeable by water, which can only follow a circuitous passage. In this way it penetrates to depths where re-actions take place, which, although not entirely in accordance with the results of daily experience in our laboratories, can, after the investigations of Daubrès, Sénarmont, and others, be readily understood. By the action of sea-water on calcic silicates, sodic silicate and calcic chloride may be produced. The sodic sulphate of the sea-water will be decomposed by this calcic chloride, with production of calcic sulphate and sodic chloride. The decomposition of clay by common salt may produce aluminic chloride and sodic silicate, while the magnesium of the magnesic chloride may be replaced by calcium ; finally a portion of the potassium in the sea-water appears to have been displaced by the lithium of the granite. *Chem. News*, *xxvii.* 62.

Estimation of Pure Sugar in various Raw Beet-Sugars.—The process described by C. SCHEIBLER is a modification of Payen's well-known method, by which syrup adhering to the already crystallized sugar is removed by washing with a saturated alcoholic sugar solution acidified with acetic acid. The following liquids are employed in the improved process :—1. Alcohol, 99 to 100 per cent. strength. 2. Alcohol of 96 per cent. saturated with sugar. 3. Alcohol of 92 per cent., also containing sugar. And 4. Alcohol of 85 per cent., acidified with 5 per cent. of its volume of acetic acid, and saturated with sugar. Of the sample of sugar to be tested about 20 grammes are weighed in tared tubes, 2 centimetres wide and 15 centimetres long, having a narrow tube fused on them at one end, and containing a plug of felt or cotton-wool just above the junction of the wide and narrow portions. These tubes are connected by their narrow ends with bottles in which a partial vacuum can be created by some convenient means, such as a Bunsen water-pump, while their wide upper extremities are closed by corks carrying two tubes, one of which serves for the admission of dry air, and the other (carrying a stop-cock) for the introduction of the washing fluids by means of a pipette. The sugar is first covered with absolute alcohol and left to stand for 15 minutes. This liquid is drawn off and replaced by No. 2, this then by No. 3, and the last by No. 4, which is allowed to stand on the sugar for 15 or 20 minutes, and is then allowed to run off slowly. More is added and run off, and so on, till the sugar parts with no more colour to the liquid. The remaining portions of No. 4 are then displaced by the other liquids, used in reverse order, and the nearly pure sugar left is dried by passing air through it while the tube is surrounded by a metallic casing filled with steam. The weight of the residue so obtained is obviously that of the sugar which existed ready crystallized in the original samples, plus sand and other impurities insoluble in spirit. It is now only necessary to "polarize" this residue

to determine the quantity of sugar which it contains, and so obtain all the data required to ascertain how much crystallized sugar was contained in the raw sample. *Chem. Soc. Journ., from Dingler's Polyt. Journ. ccvi.* 48.

Air Inclosed in Sugar Beetroot.—A. HEINTZ has made some highly interesting observations on slow combustion, or, as it is termed, respiration of beetroot. Sunlight induces chemical transformation in chlorophyll, the vegetable assimilative organ. The substances necessary to build up the body of the plant are produced from carbonic acid and water, oxygen being eliminated. The chemical intervention of atmospheric oxygen in the matters of the living plant-cell is exclusively denominated respiration, and is diametrically opposed to the assimilatory process—the absorption of carbonic acid. Dutrochet rightly compares the respiring plant with insects and other cold-blooded animals, and Sachs likens oxygen to "the spring of a watch," whose elasticity sets all the parts in motion. In the growing plant the elimination of oxygen preponderates, but when the absorption of carbonic acid is interrupted the respiratory process becomes more prominent. As early as 1779 Ingenhauss discovered that roots, flowers, and fruits give out carbonic acid. Respiration, or slow combustion, can be well observed in case of the sugar-beet root, whilst its nutrition is suspended in the winter. The roots stored up for use go on respiring, and their sugar is decomposed. It was found that a store of 1,000 cwts. of roots lost, in two months, 10 cwts. of sugar. The air contained in the roots was found to be :—

	Vols.
Carbonic acid	30·52
Oxygen	0·14
Nitrogen	69·34
	100·00

Another portion yielded :—

Carbonic acid	35·10
Oxygen	0·56
Nitrogen	64·31
	99·97

Ber. D. Chem. Ges. vi. 670.

Nessler's Ammonia Test.—WANKLYN remarks that according to some experiments a few minutes suffice for the full coloration, according to others half an hour or more is necessary.

These differences have their origin in differences in the quality of the Nessler re-agent; different samples, although ultimately giving the same depth of colour with the same quantity of ammonia, yet requiring very different times for the production of the coloration. One sample of Nessler re-agent gives its maximum of colour almost immediately, and another sample takes a quarter of an hour or an hour for full development.

To a great extent, these differences depend upon whether or not a sufficient quantity of solution of corrosive sublimate has been added to the finished Nessler re-agents. Whether the Nesslerizing takes a couple of minutes, or whether it takes an hour, is a matter of importance to those persons who are working the ammonia process of water analysis; and since this process is now frequently used in cases where speed is of importance, the author has deemed it worth while to direct attention to the necessity of a careful preparation of the Nessler re-agent. *Chem. News, No.* 711.

§ 5. *Fuel, Gas, Heating, Light, Photography, &c.*

Anthracene Manufacture.—The Parisian Lighting and Gas Heating Company patent the following process for extracting all the anthracene present in coal tar without carbonizing or coking the pitch; by keeping up a continual agitation of the pitch, coking is prevented. This is effected either by mechanical means or by an inert gas, such as lighting gas, carbonic acid, atmospheric air, or preferably the gases arising from the combustion of coal or coke. The coking arises from overheating of the badly-conducting material before all the anthracene is distilled over; the agitation prevents this. If the pitch is too thick it can be reduced to a proper consistence by addition of heavy oils. *Bulletin Soc. Chim. Paris, xx.* 138.

Fat from Sheeps' Wool.—E. SCHULZE finds that cholesterine and a body isomeric therewith are present in the fat from sheeps' wool; this *isocholesterine* melts at 137°—138°, and is crystallizable from ether. *Berichte der Deut. Chem. Ges. vi.* 251.

Determination of High Temperatures.—J. SALLERON describes an instrument for the purpose of determining temperatures superior to the boiling point of mercury: it consists of a copper vessel containing a known quantity of water, and furnished with a thermometer and agitator; to avoid loss of heat by radiation, an air jacket surrounds the copper vessel or calorimeter; this jacket consists of an outer cylinder of brass under which the copper vessel is fixed by means of an annular disc of wood. A cylindrical mass of copper is heated in the flame, &c., the temperature of which is to be determined, and quickly dropped into the water; the rise in temperature after thorough stirring is determined by the thermometer, and the heat communicated to the water, and hence the initial temperature of the mass of copper thence calculated. For temperatures higher than the melting point of copper, a lump of platinum may be used. *Les Mondes, xxxi.* 522.

[This instrument is by no means new, it being only a very slight modification of Siemens' well-known "water pyrometer," with which it is identical in principle. *Chem. Ed. P. M.*]

Maximum and Minimum Thermometer.—HERMANN and PFISTER manufacture a thermometer formed of a compound spiral, consisting of two differently expansible metals electro-plated. By increase of temperature it tends to unroll, by decrease to twist up; in so doing it moves one or other of a pair of indices over a graduated scale, the one of which registers the highest temperature attained, the other the lowest. If required, a third needle may be added, by means of which the actual temperature at any moment may be read off without disturbing either of the other pointers. The instrument is used at several meteorological stations in Switzerland and Russia, and gives great satisfaction. *Les Mondes, xxxi.* 527.

Glass for Photographers' Dark Rooms.—LE NEVE FOSTER finds that ruby-red glass absorbs all the blue and green rays of the spectrum, and is hence better fitted for the purpose of absorbing actinic rays, and preventing chemical action, than the ordinary yellow glass, which does not absorb all the blue rays. *Dingler's Polytech. Journal*, 207, 427.

Use of Aniline in Photography.—TRONQUOY saturates paper in the dark with a solution of bichromate of potassium acidulated with sulphuric acid, dries, exposes to light under the object to be copied; after printing, the paper is exposed to aniline vapour, whereby the unreduced chromic acid is acted on, giving shades varying from green to blue violet; finally the design is thoroughly washed and dried. *Bulletin de la Soc. Française de Photographie, No.* 6, 1873.

Photolithography.—PAUL impregnates the paper of the Autotype Company with a mixture of equal parts of *albumin* and a saturated solution of potassium dichromate; after exposure, the unaltered albumin is dissolved out by cold water. This process is preferable to the use of *gelatin* as ordinarily employed, as a much sharper and clearer image is transferred to the stone. *Dingler's Polytech. Journal*, 207, 429.

Phosphorescent Pictures.—SEELHORST prepares various substances which phosphoresce in different colours, mixes them with melted paraffin, and paints them on glass so as to imitate flowers, &c.; when illuminated with magnesium wire, and placed against a dark background, beautiful objects may be thus produced. Amongst other substances the author mentions—

1. *Green Phosphorescent Powder*, prepared by heating strontium thiosulphate (hyposulphite) over a lamp for fifteen minutes, and then heating the residue five minutes before the blowpipe.

2. *Blue Phosphorescent Powder*, made by mixing strontium sulphate with an impure sulphate prepared from the chloride, reducing the mass in hydrogen and heating. *Dingler's Polytech. Journal*, 207, 220.

Purification of Coal-Gas.—A. VERNON HARCOURT and F. W. FISON describe a continuous process for purifying coal-gas and obtaining sulphur and ammonium sulphate. The usual method of freeing coal-gas from sulphuretted hydrogen is by passing it through lime. Oxide of iron is also employed in place of the lime, the advantage possessed by the oxide being that whilst the lime, after it has served its purpose, is useless and difficult to get rid of, the oxide of iron can be used repeatedly for the same purpose, as it becomes changed into sulphide of iron; when this is exposed to the air, sulphur separates and the oxide is re-formed, and can be used over again. This might be called a *continuous* process, because the oxide can be continuously used. But the process is not quite continuous, for after the oxide has been used some thirty times, it becomes so clogged with sulphur as to be useless, except perhaps for smelting into iron. The advantage of the new process is that the oxide can be used over and over *ad infinitum;* and besides, the ammonia is secured in a marketable form. The

present method of freeing gas from ammonia by "scrubbing," or passing it through a large receiver containing a small quantity of water spread over a large surface, has one or two defects. It does not secure the ammonia in a good form, and it probably diminishes the illuminating power of the gas, by removing olefiant gas. The new process is applicable wherever oxide of iron can be used in the purifying process. The difference from the old process is that the oxide during use is moistened with a solution of ferric sulphate (persulphate of iron), a portion being removed from time to time and lixiviated with water. The soluble salts formed are sulphate of ammonia—formed in the purification by the reaction of ammonia and ferric sulphate—and in smaller quantities, sulpho-cyanide, hypo-sulphite, and probably other salts; the liquor obtained by lixiviation is mixed with a small excess of sulphuric acid; and yields when concentrated by evaporation, crystals of ammonium sulphate. The remainder of the substance is then boiled with dilute sulphuric acid, which dissolves the oxide and leaves a residue of sulphur. The actual process of extraction by acid consists in treating the substance successively with (1) a solution of ferric sulphate containing some free sulphuric acid; (2) with a more dilute solution of ferric sulphate to which sulphuric acid has been added; (3 and 4) with more dilute solutions of ferric sulphate—all these liquids being the product of a former extraction; and (5) with water. The liquid resulting from the first of the treatments enumerated above is a strong solution of ferric sulphate, which is used as already mentioned, being mixed with the charge of oxide before it is replaced in the purifier. The residue of the final washing consists almost entirely of sulphur, and requires only to be dried. It is evident that all the oxide which has been freed from sulphate of ammonia and sulphur by this treatment passes into the condition of ferric sulphate, and in this condition it is replaced in the purifier. There it again becomes oxide by the action upon it of the ammonia in the gas, which it completely removes, fixing it as sulphate. This system has been tried on a small scale, and found to be apparently successful. *Brit. Assoc. Bradford, Chem. Sect.*

§ 6. *Electricity, Magnetism, Telegraphy, &c.*

Electric Effluvium.—MONCEL applies the term "condensed effluvium" (*effleuve condensée*) to the luminous discharge produced by the passage of an induced current between two plates of glass separated by an interval of about three millimetres, and having their outer sides connected with the two poles respectively of a Rhumkorff's coil. This discharge differs entirely in character from the direct spark, producing (as Brodie, Thénard, and others have shown) peculiar chemical effects. *Comptes Rendus*, 76, 1015.

Electrical Condensation.—NEYRENEUF sums up the results of his researches thus:—

1. The constancy of charge in the ordinary electrophorus depends on imperfect contact.
2. The use of a proof-plane in quantitative, and even in qualitative, researches as to the electrization of an insulating plate, is very defective.
3. The use of a gold-leaf electroscope requires great precaution, as the insulating plate of the condenser acts as an electrophorus.
4. An electrophorus, when placed in the conditions theoretically best, gives little effect, as there is antagonism between the spontaneous discharge and that due to the ordinary action of the instrument. *Comptes Rendus, July* 21, 1873.

Electro-deposition of Iron.—JACOBI has made experiments to see if the reduction of iron from a solution of sulphate of iron by the passage of a current is accelerated by exposing the electrolytic cell to magnetic influence, and finds that no appreciable difference is produced thereby. Electro-deposited iron is hard and brittle, but becomes ductile and malleable after annealing at a red-heat. By a process resembling cementation it may be made as hard as glass, but by frequently annealing this hard substance it becomes again soft. A tube of electro-deposited iron can acquire an intense temporary magnetism which wholly disappears when the magnetizing influence is withdrawn, no "residual magnetism" whatever being left. The degree of temporary magnetism is equal to that attained by a similar mass of ordinary soft iron of the same shape. If a tube of electro-deposited iron be used instead of the wire of an induction coil, it develops physiological commotions to a greater extent than are produced by a cylinder or tube of soft iron of the same dimensions. On the other hand, if a bundle of soft iron wires of the same weight as the galvanic tube be used instead, shocks sensibly equal to those given with the tube are produced. *Ann. Chem. Phys.* [4] 28, 252.

Nickel-plating.—UNWIN patents the use of double sulphate of nickel and ammonium prepared in a special way, the anode being formed by melting and casting in plates the grain nickel of commerce. *Bulletin Soc. Chim. Paris*, xx. 143.

Electrical Resistance of Metals.—BENOIT has determined the resistance of a number of metals at the temperatures of boiling water, and the boiling points of mercury, sulphur, and cadmium (360°, 440°, and 860° respectively) and hence calculates the following formulæ.

For most metals, the resistance R_t at a temperature t° is related to R_0 (the resistance at 0°) in the following manner:—

$$R_t = R_0 (1 + at + bt^2).$$

Where *a* and *b* are constants depending on the nature of the metals: with *brass*,[1] *aluminium bronze*,[2] "*maillechort*,"[3] however, the relationship is expressed by the formula—

$$R_t = R_0 (1 + at),$$

i.e. in the first formula *b* has the value 0.

Metal.	Value of *a*.	Value of *b*.
Steel	0·004978	0·000007351
Iron	0·004516	0·000005828
Tin	0·004028	0·000005826
Thallium	0·004125	0·000003488
Cadmium	0·004264	0·000001765
Zinc	0·004192	0·000001481
Lead	0·003954	0·000001430
Aluminium	0·003876	0·000001320
Silver	0·003972	0·000000687
Magnesium	0·003870	0·000000863
Copper	0·003637	0·000000587
Gold	0·003678	0·000000426
Silver	0·003522	0·000000667
Palladium	0·002787	0·000000611
Platinum	0·002454	0·000000594
Mercury	0·000822	0·000001140
Brass	0·001599	
Aluminium bronze	0·001020	
"Maillechort"	0·000356	

The values of R_0 with reference to Siemen's unit (a column of mercury 1 millimetre square in section and 1 metre in length) are given by the following table:—

Silver	0·0161
Copper	0·0179
Gold	0·0227
Aluminium	0·0324
Magnesium	0·0443
Zinc	0·0591
Cadmium	0·0716
Steel	0·1149
Tin	0·1214
Iron	0·1272
Palladium	0·1447
Platinum	0·1647
Thallium	0·1914
Lead	0·2075
Mercury	1·0000
Brass[1]	0·0723
Aluminium bronze[2]	0·0243
Maillechort[3]	0·2775

Comptes Rendus, 76, 342, *and Revue Scientifique, July* 26, 1873, *p.* 89.

Note on Magnetism.—DU MONCEL discusses the explanation of some of Gaugain's recent experiments on the mag-

[1] Containing—

Copper	64·1
Zinc	33·1
Lead	0·4
Tin	0·4
	100·0

[2] Containing—

Copper	90
Aluminium	10
	100

[3] Containing—

Copper	50
Nickel	25
Zinc	25
	100

netization set up in a soft iron armature by a horseshoe permanent magnet and the reaction of this armature on the magnet itself. *Comptes Rendus, July* 14, 1873.

Influence of tempering and annealing on the magnetism of Steel and Iron.—JAMIN finds that the highest temporary magnetism is communicated to soft iron, tempered steel taking up a much less amount in proportion inversely with the degree of hardening. Thus, whilst a given bar of hard cast steel, annealed at a red heat and treated with a current from twelve elements, attained to a force measured by 1,290 grams, the same bar, when hardened and subjected to the same current attained only to a force of 75 grams. Very hard good steel in thin plates yields very poor permanent magnets, but poorer steels, when highly hardened and not annealed, become powerful magnets. To attain the maximum of polarity the conditions vary with the character of the steel; average poor steels attain the maximum only after extreme hardening; better steels, on the other hand, do not give so high a degree of polarity after much hardening, as they do after partial tempering, the amount of tempering necessary to give the maximum power being proportionate to the degree to which the hardening had been carried. No rules can be given for the treatment of an unknown kind of steel; experiment only can decide as to the mode of treatment requisite to communicate the maximum magnetic intensity. The author gives tables of the amounts of magnetic power, and the co-efficients of polarity attained by various kinds of steel examined. *Comptes Rendus, July* 14, 1873.

§ 7. *Miscellaneous.*

New Explosives.—PAPILLON gives a digest of the labours of various experimenters who have studied the subject of projectiles and explosive substances. Count Rumford measured the explosive force of gunpowder in a rough way by exploding small quantities in a small vertical cannon closed by a heavy weight; he estimated that the force required to rupture the cannon was equal to 100,000 atmospheres pressure, but subsequent calculations indicate that this estimate is much too high. Rodman in 1857 invented the *crusher guage*, which indicated pressures of 5,000 to 8,000 atmospheres in the hands of an English commission.

By means of wires stretched across the bore of a gun connected with a chronoscope, and cut successively by the passage of the ball, estimates of the pressure and the velocity of discharge were obtained by this commission. Thus, with the powders *R.L.G.* (rifle large grain; irregular hard grains, weighing on an average 5 centigrams); *pebble* (angular grains, weighing 2 to 5 grams): *pellet* (cylindrical grains, weighing 5 grams): and *Russian prismatic powder* (weighing about 40 grams per grain); the following results were obtained:—

R.L.G., maximum pressure developed almost instantaneously; 4,690 atmospheres at the end of $\frac{1}{30000}$ second, the ball having only moved 1·5 centimetres.

Pebble, maximum pressure 2,420 atmospheres when the ball had moved 20 centimetres.

Pellet, maximum pressure 2,730, after traversing 11 centimetres.

Russian prismatic, maximum pressure 3,230 atmospheres, after traversing 15 centimetres.

In order to estimate the velocity of transit of projectiles, the old ballistic pendulum was first employed; then electric registrations, connected with wires cut by the ball in its passage; also a simple method, invented by Deprez, consisting of observing the track of the ball furnished with a fuse through a telescope fixed to a vibrating fork, giving a known musical note: from the sinuous path, apparently described by the burning fuse, and the pitch of the note, the velocity can be calculated.

The amount of *vis viva* actually communicated to a projectile is a much greater fraction of the energy contained in the explosive substance than is the *vis viva* obtainable from the best steam engine of the energy contained in the coal burnt: machines at low pressure only give 1 to 2 per cent. of the power theoretically obtainable, high-pressure engines giving 6 to 9 per cent., the remainder being used up in overcoming friction and producing heat, or never being utilized at all, *i.e.* escaping as hot gases, &c. from the chimney. Good gunpowder, however, may give as high a yield as 20 or 25 per cent. of the energy theoretically obtainable. The difference in cost between gunpowder and coal, however, would render a steam cannon much cheaper than the ordinary artillery, were it practicable to develop the high velocities requisite by means of a steam engine; thus to impress a velocity of 400 metres per second on a ball weighing 10 kilograms, a steam-engine of one-horse power (75 kilogram-metres per second) would require to work eighteen minutes, consuming 400 grams of coal, costing one centime. The cost of gunpowder requisite to perform the same duty would be three francs.

Berthelot has deduced the following numbers from his experiments. Column 1 gives the heat furnished by one kilogram of substance; Column 2 the volume of gas disengaged, and Column 3 the product of these two quantities, which represents more or less accurately the explosive power.

	Heat.	Bulk of gas.	Explosive power.
Mining powder	509 calorics	0·173	88
War „	608 „	0·225	137
Hunting „	641 „	0·216	139
Nitrate of soda „	764 „	0·248	190
Chlorate of potash „	972 „	0·318	309
Gun-cotton . . .	590 „	0·801	472
Picric acid . . .	687 „	0·780	536
Picrate of potash . .	578 „	0·585	337
Various mixtures { Gun-cotton	1420 „	0·484	680
Various mixtures { Picric acid	1424 „	0·408	582
Various mixtures { Picrate	1422 „	0·337	478
Nitro-glycerine	1320 „	0·710	939

Hunting-powder, therefore, gives little more explosive force than war-powder, although it yields more heat on combustion; mining-powder, on the other hand, which contains less nitre, gives less heat and less explosive power. Nitrate of soda powder has more explosive force than saltpetre powder; but experience in cutting the Suez Canal indicates that this advantage, as well as its less cost, are counterbalanced by its hygrometric properties, and the greater difficulty of inflammation. Mixtures with chlorate of potash have very high explosive power; but the ease with which they detonate by friction is a great bar to their use. Gun-cotton gives three times the explosive force of gunpowder, although its heat of combustion is no greater; for this very reason it is less adapted to firearms, on account of the liability to bursting thereby produced. Nitro-glycerine, were it not so dangerous, would unite all the advantages of the others; for it burns completely without residue, gives twice as much heat as gunpowder, and three and a half times as much gas; with equal weights it has seven times the explosive power of gunpowder; with equal bulks twelve times as much. Only one other body, liquid protoxide of nitrogen mixed with ether, or liquefied hydrocarbons, gives a higher value, viz., 1,000, the heat being 1,400 calorics. Gaseous detonating mixtures give more heat than either solid or liquid compounds; thus oxygen and hydrogen gives 3,280 calorics when water is produced; benzene or ether give 2,400. The pressures developed, however, are not so great, as the increase in volume is not so large as in the case of solids or liquids. *Moniteur Scientifique Quesneville, August* 1873, *p.* 718. *From the Revue des deux Mondes, July* 15, 1873.

Determination of the Relative Powers of Explosive Bodies.—TROMENEC explodes (by an electric current) the substances to be examined in a stout vessel immersed in a calorimeter. The force developed necessarily appears wholly as heat, no mechanical projection being possible: hence the amount of heat developed measures the relative force of a given weight of explosive substance. *Comptes Rendus, July* 14, 1873.

Determination of Boiling Points.—H. BUNTE has devised an apparatus whereby the boiling point of a liquid at the normal pressure (760 millimetres) may be observed, even though the atmospheric pressure at the time is different from the standard amount. *Annalen der Chem. und Pharm. clviii.* 139.

Hair Hygrometer.—HERMANN and PFISTER manufacture hygrometers with hair as the indicative substance; the hairs used are carefully cleaned and then subjected to air, at an extreme dryness (or zero), and at an extreme moisture of 100 degrees, the hygrometric state of the air being made to pass artificially from the one extreme to the other about twenty times; this treatment is indispensable to enable the hair to register hygrometric states accurately, and to render its indications comparable with those of another hair. *Les Mondes, xxxi.* 526.

Ventilation of Ships.—THIERS of New Orleans utilizes the rolling or pitching motion so as to produce ventilation; the apparatus employed consists of two reservoirs connected by a tube; these are placed on opposite sides of the main deck, or at opposite ends, according as it is required to work by rolling or pitching. The reservoirs and the connecting tube are partly filled with water; as the vessel heels over, the water passes to the reservoir at the lowest level, and consequently air is drawn in to the higher one; when equilibrium is restored, this air is again expelled. Hence, by affixing a simple valve and suitable connections, fresh air may be forced down to the bottom of the hold or foul air may be pumped up, or in time of fog a trumpet

FAUTEUIL. By Mazaroz-Ribalier.

Style of Henri II. (1547-59.)

may be blown by the issuing air, the whole being executed automatically. Experience demonstrates that a roll of 3 centimetres (1·2 inch) is sufficient to make the apparatus work well. By substituting mercury for water in the apparatus, sufficient power is gained to pump up bilgewater; thus a roll of 35 centimetres will pump up water 10 metres. *Les Mondes, xxxi.* 556.

Mechanical Evaporation.—JOSELLI evaporates the aqueous solution of nitrate of ammonia, &c., obtained in making freezing mixtures by means of a simple mechanical contrivance. A cylindrical vessel is nearly filled with water, and heated to boiling over a fire; on this vessel rests a trough containing the liquid to be evaporated. A series of vertical discs are arranged on a horizontal axis so that the discs dip into the liquid to be evaporated; these discs are connected, by means of pulley and band, with another axle, at the extremity of which is a kind of wheel furnished with vanes turned round by the current of steam issuing from a jet in the side of the lower vessel or boiler. As this wheel turns, the series of discs is made to revolve at a much slower rate (the pulleys of the axles being of unequal size, that on the vane-wheel axle being much the smaller). A large surface for evaporation is thus presented, the discs being continually wetted with the solution to be evaporated, and exposed to the air as they revolve; the temperature of the solution to be evaporated consequently does not exceed 50° or 60°, a point of importance when nitrate of ammonia is the salt to be recovered, as a higher temperature might decompose it. When solid crystalline matter appears on the discs the contents of the upper vessel are poured out and allowed to solidify; if poured into a vessel covered internally with minium, the removal of the solid mass is more easily accomplished. The whole arrangement thus works automatically, and the recovery of the dissolved salt is effected at very small cost. *Les Mondes, xxxi.* 525.

Pneumatic Dispatch.—TOMMASI and MICHEL propose to substitute ammonia gas for compressed air in the working of subterraneous tubes for atmospheric dispatches. The gas is first used in the state of aqueous solution, from which it is expelled by heat. Sufficient power is thus obtained to propel the dispatch to the far end, when the ammonia is again absorbed by cold water. The inventors consider that the cost of fuel will be smaller than in the ordinary method. *Les Mondes, xxxi.* 542 and 624.

Muscular Force in Insects.—PLESSIS states that a specimen of *Lucanus cervus*, Latr., weighing 3·20 grammes, was able to move with a box balanced on its back, and containing weights equal to one kilogramme; *i. e.* that it supported and moved about with a load 315 times its own weight. A very strong man has less than one-hundredth of this power; were an elephant strong in proportion, it would gallop with the Luxor column on its back, this only weighing 230,000 kilogrammes (about 230 tons). *Les Mondes, xxxi.* 552.

Preparation of Resorcin.—E. KEPP recommends for this purpose the dry distillation of the impure brasilin obtained in the manufacture of Brazil wood extract; on heating this yields a large quantity of very pure resorcin, this method being the cheapest, simplest, and easiest of any yet proposed. *Berichte der Deut. Chem. Ges. vi.* 446.

To Fasten Leather to Metals.—F. SIEBURGER recommends the following process by Fuchs. Digest one part of crushed nutgalls with eight parts distilled water for six hours and strain; macerate glue with its own weight of water for twenty-four hours, and dissolve; spread the warm infusion of the galls on the leather, and the glue on the roughened metallic surface; apply the prepared surfaces together, and dry gently; the leather then adheres so firmly to the metal that it cannot be removed without tearing. *Polyt. Notizblatt.*

Prevention of Mould in Gum.—HIRSCHBERG adds a few drops of sulphuric acid, whereby the lime contained in the gum is precipitated as sulphate; after standing, the mucilage is strained off, and exhibits no tendency to mouldiness even after standing for eighteen months. *Les Mondes, xxxi.* 545.

Solution of India-rubber for the Manufacture of Elastic Tissues.—The raw india-rubber is soaked in clear water, and boiled for about an hour to remove dirt. It is then taken out of the water, and cut into round slices about 1 centim. in thickness. It is then rolled out into layers about 2 metres long and 0·15 metre broad. The rubber is then dried in a warm chamber. After the drying follows the solution. About 26 kilos of rolled caoutchouc are placed in a wooden vat lined with zinc, and treated with a mixture of 50 kilos benzol and 70 kilos oil of turpentine. Both these liquids must be perfectly free from fatty matters, or the solution of india-rubber will be useless. The caoutchouc, before being brought in contact with the solvents, is torn up into small fragments. The mass is stirred occasionally till it forms a thick, homogeneous liquid. To test the benzol and turpentine, small portions of each are evaporated to dryness in the water-bath. If any trace of fat remains the sample is at once rejected. *Reimann's Färb.-Zeit.* 1873. *No.* 25.

THE NEW EXPLOSIVE SUBSTANCES.

BY M. FERNAND PAPILLON.[1]

I.

MAN has always been ambitious above his means; there is no proportion between our aspirations and our organs. Nature has given us arms too short, and loins too feeble, to allow us to satisfy our desires. The Titans who piled up mountains and scaled the skies, the gods and goddesses who did so many marvellous things—Mars, who hurled all his enemies to the earth—Iris, who bore messages with the speed of a flash of lightning—what do these and so many other poetical myths all prove if it be not the antiquity of hopes and dreams that in our own days are scarcely realized? When the Prometheus of Æschylus, rebelling against the decrees of Jupiter, enumerates all that human art has drawn from the breast of Nature, and sets in opposition to the master of Olympus "that indomitable giant who shall find a fire more potent than the thunderbolt, a noise that shall deaden the thunder-peal, and who shall shatter Neptune's sceptre," he seems to have perceived, through the dim veil of the future, those marvellous conquests of which we boast to-day.

To condense and concentrate force in an engine which raises us to the level of a giant or a god; to enclose in a terrible weapon the death that we can from afar hurl into the enemy's camp; to imprison mechanical energy in an instrument which allows us to perform the labours of an athlete—these have been the charms of inventors from the time of Archimedes to the days of Albert the Great, and those modern "condensers of quintessences" who weigh the atoms and then group them in terrible combination. The traces of these ideas can be followed backward, step by step, to times the most remote, where the marvellous mingles with the real, throwing a cloud of suspicion and obscurity on all that has come down to us. Of this, however, we may be certain, that the ancients knew the power of some inflammable substances which could be hurled upon the enemy to burn his defences. In India, where the efflorescence of saltpetre covers the plains bordering on the rivers, this substance has been used from time immemorial to compose flying fires. The Arabs, learning this art from their neighbours, termed it "Indian snow;" and the Arabs, as well as the Greeks of the Lower Empire, made a considerable use of incendiary projectiles which they threw with war-machines; the Sire de Joinville, in his "Histoire de Saint Lovys," relates that the Crusaders suffered much from these projectiles.

Since the twelfth century the Western world has known the properties of the mixture of saltpetre, sulphur and charcoal; old manuscripts, dating from that epoch, contain recipes for the composition of gunpowder, in nearly the same proportions as obtain to-day. Marcus Græcus indicates divers uses of it in his "Livre des Feux," of which the "Bibliothèque Nationale" possesses two copies. It seems to be proved that this author lived before the ninth century, but the "Liber Ignium" as we have it was probably not edited before the twelfth. We find in its pages the mode of fabricating a fuse (*tunica ad volandum*), a recipe for composing Greek fire, and other means of "fighting the enemy with fire as well on sea as on land." Roger Bacon gave the composition of gunpowder, while half disguising his formula under a cabalistic anagram; he says that this mixture produces much light with a horrible explosion, and that it will permit the destruction of a town or of an entire army.

Powder was at first used only for fireworks and for incendiary purposes; it was placed in fire-tubes fitted with fuses, which were shot like arrows by means of cross-bows. Soon it was itself utilized as a motive power in mortars, bombards and *venglaires* which vomited forth stones and brazen balls. In the

[1] This article is translated, by permission, from a recent number of the *Revue des deux Mondes*. We have to thank the editor for his courtesy. We have also to express our obligations to M. R. Radau for the corrections he sends us from the *Revue* office relating to some calculations he had contributed to M. Papillon's article; these have been carefully introduced into our text.—H. C.

first half of the fourteenth century fire-arms of a small bore came gradually into use. "Still not long ago," writes Petrarch, "this plague was rare, now it is as common as any sort of arm." Large artillery began before long to take the place of the ancient war-engines which were used to throw projectiles into besieged towns. Nevertheless it would be an error to believe that the discovery of the projecting properties of gunpowder produced an immediate revolution in the art of war.

The first experiments with large artillery gave but indifferent results, for many things were yet wanting to complete the invention. The bombards at first produced more terror among those who fired them than damage among the enemy. Not only did the pettiness of the results obtained, the uncertainty of the aim, and the danger of employing novel arms, bring discredit upon them, but for long their use was considered as little chivalrous, not to say disloyal. How far are we removed from those times! At the close of the sixth century fire-arms were not yet definitely accepted; witness old Montaigne, writing about the year 1580:—"Spite the stunning of the ears, to which all will soon become accustomed, I esteem it as an arm of very little utility, and I hope that we shall some day leave off its employ altogether." In the English army we find archers as late as the year 1627, at the siege of the Isle of Ré; and the writers mourned over the growing use of fire-arms as a symptom of decadence. However, by degrees the artillery became more perfect and gunpowder began to be employed for blowing up ramparts; at the siege of Belgrade, in 1441, mines were sprung with much success.

In every country powder-mills of one form or another were established to manufacture gunpowder on a large scale, and thus meet the growing demands of the various governments. Originally the mixture of saltpetre, sulphur, and charcoal was employed in the form of powder or dust, no matter for what purpose it was destined; more than a century elapsed before the superiority of granulation was discovered. Then the grains were made of all sizes, lumps as big as filberts, as peas, as lentils, as flax-seeds. To-day, cannon-powder ordinarily measures an average of two millimetres, musket-powder one millimetre; but for cannon of heavy calibre they use a much larger grain. The grains of the Belgian powder made at Wetteren, and of the English "pebble powder," have an average thickness of fifteen millimetres; the Prussian prismatic powder is composed of hexagonal prisms twenty-five millimetres high by a transverse section of forty millimetres, pierced with little canals so as to facilitate the inflammation; each of these prisms weighs forty grammes. The proportion of the ingredients was, in the earlier times, very varied; in fact they tried all possible proportions; yet they were not long in settling upon the proportion which has been acknowledged, ever since the sixteenth century, as the most advantageous *six, as et as*, that is to say, six parts of saltpetre, for one of sulphur and one of charcoal. This is the proportion still adopted in France for powder for war purposes; mining-powder contains six parts of saltpetre to two of sulphur and two of charcoal.

Like bread, gunpowder has become an article of current manufacture, the recipe of which has not varied for centuries, although few substances have been more studied, tried, and tested. The smallest details as to the effect of granulation, the smoothness and drying of the proportions, and the special qualities of the ingredients, have been carefully examined. Good powder is obtained not only by mixing in the proper proportions, but every phase of the manufacture has its own importance, each conducing to the final result. A striking example will show how much we would be deceived if we imagined that nothing more was necessary than to blend the saltpetre, sulphur, and charcoal together. In the year IV. (of the Republic), when they would, as the saying is, "have made arrows of all woods," a commission, composed of Borda, Pelletier, and d'Aboville, were instructed to study simple mixures of this kind. They experimented in firing; a 10-inch bomb with a charge of 4 kilogrammes was thrown in three successive shots for distances of 32 metres, 1,160 metres, and 77 metres, while the same charge of true powder should have carried the bomb almost 2,800 metres. In one cannon a charge of 4 kilogrammes hung fire for a whole minute before the ball departed. We need not, then, be astonished at the extreme importance that is attached to the process of trituration (by millstones, pestles, kibbles, and presses) and to the proper making of the grains. Finally, the preparation of charcoal, the collection of saltpetre and sulphur, have given birth to special industries.

We know how necessary azote is to all vegetation, and we recognize the efficacy of the nitrates as manures; thus saltpetre (nitrate of potash) is in demand for farms as well as for the powder mills. It is not made in factories, but is drawn from the bosom of the earth, where it is spontaneously formed by obscure and mysterious actions; so the acceleration of the production is forced by the establishment of artificial nitre-beds, where the earth intended to be made into nitre is sheltered from the rain, and periodically watered with lye—washings of dung-heaps. During the last century remarkable quantities of saltpetre were imported into Europe from the East Indies; and for the last forty years nitrate of soda, known also as the saltpetre of Chili and Peru, has been brought to us from the desert plains stretching at the feet of the Andes chain. There they find the nitre on the surface of the soil, in masses more or less compact, and these beds seem inexhaustible, for they think they have noticed that, after a period of time, the saltpetre forms again in the place from whence it has been gathered. The Peruvian port of Iquique has assumed such an importance since the discovery of nitre in the province of Tarapaca, that the population is incessantly increasing, in spite of the barrenness of the soil and the want of fresh water, which they are compelled to procure from a distillation of salt water.

Much powder was burnt in the great wars of the fifteenth century, and henceforth the collection of saltpetre became a lucrative trade. An edict, dated 1540, regulated the industry in France by instituting "Salpêtriers Commissionés," and after that date every new war was the occasion of fresh laws, all aiming at a rigorous renewal of the privileges enjoyed by saltpetre merchants, who had rights over lands and the nitrous matters of stables, sheep-pens, styes, dovecots, &c., and the plaster rubbish of ruins; they had the right of "the spade" on the condition only that they respected the foundations of all buildings. The communes were obliged to furnish them with wood for their labours, often with warehouse-room and transport for their merchandise, without reckoning a crowd of other privileges, rights and exemptions, which varied in the different provinces, and which were an eternal source of abuses and complaints. This visit took place every three years. In return the government fixed the price at which they took delivery of the saltpetre. At the time of Louis XIII. the total amount of saltpetre manufactured in the whole of France amounted to $3\frac{1}{2}$ million pounds. The importation of saltpetre from India considerably lowered this industry at the very time that the advance of civilization compelled the government to restrain these vexatious privileges. It became more and more a small-profit business, in which the process of extraction had to be perfected as much as possible, so as to utilize all the residue, and thus prevent an absolute loss.

They then began to introduce artificial nitre beds, already used in Northern Germany. These are large sheds, where, sheltered from the rain, they place light earth mixed with all kinds of organic *débris*, and straw or branches, to facilitate the circulation of the air; it is stirred about from time to time, and sprinkled with liquid manure, in order to quicken the nitrification. The slow oxidation of the azote matter, at the contact of air in earth so prepared, supplies nitrate in great abundance. The materials are washed with liquid-manure once a year, and it is not necessary to renew them more than once in ten years. Neither were they long in discovering that there exist in France calcareous earths, naturally fertile in saltpetre, which did not require to be thus prepared; such, for instance, are the calcareous beds of La Roche-Guyon, the sandy-chalk of Touraine and Saintonge. In spite of all this the saltpetre manufacturers were only able to struggle against importation by the aid of their privileges; but these privileges were contrary to the spirit of the times, and they were abolished in 1792, when wars broke out on all sides, and compelled France to procure her saltpetre at any price.

The famous decree of the year II. invited all citizens to lye-wash whatever materials were capable of furnishing nitre, and also published detailed instructions for these improvised manufacturers. The "fête du salpêtre" celebrated the results of their first efforts. In a single year the number of workshops rose to six thousand, and the production to 16 million pounds, and in the following year it was still further increased by 5 million pounds. They had to feed the 19 thousand pieces of artillery that had been made from iron and from bronze in the single year 1793. In the year V. a definite organization governed an industry thus enlarged. This was the origin of the actual "service des poudres et salpêtres" which depends on the Minister of War. At the declaration of peace, trade was renewed again with India; later on the discovery of the nitrate of soda at Peru dealt the national industry such a blow as it never more recovered; and it died of old age. The siege of Paris recalled its memories. In the month of October the scientific committee presided over by M. Berthelot, submitted to the Government of National Defence a report upon the means of extracting saltpetre from the Parisian soil. He estimated the quantity of nitrate that he could thus obtain at many thousands of kilogrammes, without counting what might be extracted from cinders and ashes; and he proposed to orga-

nize a general gleaning, and the proposition was actually begun to be put in execution.

Of the three ingredients of which gunpowder is composed, charcoal, if it is the commonest, is also that which requires the greatest care in preparation, and the quality of this ingredient determines the value of the whole product. It requires to be very dry, crisp, light and porous, and extremely friable, so as to leave a minimum of ash. It is obtained by slow carbonization, in closed vessels, from white woods, such as the osier, the willow, the hazel, and above all, the alder. It is not pure carbon; the charcoal of gunpowder contains much oxygen and hydrogen, in nearly the same proportions as water.

The sulphur comes to us from volcanic districts, chiefly from Sicily, which has the privilege of supplying all Europe with her two hundred mines, producing annually 250,000 tons of raw sulphur. Roumania and Tuscany scarcely furnish 4,000 tons, and at Pouggoles the sulphur beds are at present abandoned. In addition to the manufacture of gunpowder, sulphur is so largely employed in all trades, that we might accurately judge the industrial development of a country by its consumption of sulphuric acid. Forty years ago Ferdinand II., King of Naples, thought to profit by this fact, by levying a tax from all Europe. Always short of money, he imposed such a duty on the export of sulphur that he doubled the price. This absurd measure had only the effect of drawing the attention of chemists to a common mineral, and one widely scattered (pyrites), which could readily be manufactured into sulphuric acid. The present consumption of Europe amounts to 800,000 tons of pyrites, which is equivalent to 250,000 of pure sulphur—almost as much as all Sicily can produce. In the neighbourhood of Apt, in the department of Vaucluse, and near Florac, in Logère, there exist beds of native sulphur which have never been touched.

II.

Although it possesses an historical past, and five centuries of use, gunpowder is not exempt from inconveniences. Owing to the sulphur it contains, it produces a bitter and unhealthy smoke, which blinds one and attacks the lungs, which is especially noisome in the mines, where it can only be slowly dissipated. Powder thus befouls the bore of the cannon, from whence comes the necessity of allowing for what they call *wind*—that is to say, of having the bore a trifle larger than the diameter of the projectile. This solid residue, which is presented in the form of smoke or dirt, proves that the combustion of the elements is incomplete. Finally, the explosive force of mining powder does not ordinarily suffice to produce all the effects desired from it. For certain work, indeed, it shows itself impotent. Thus they have very often sought for some mixtures which possess the same energy of action, and which could furnish similar, if not superior, results, at a less cost, with less residuum, and without a cloud of smoke.

In black powder the charcoal plays the part of combustion, the saltpetre that of the chief comburent;—it is a true magazine for oxygen in a solid state. The oxygen which it supplies burns the charcoal, and thus produces carbonic gas, to which the freed azote is added. These are the impulsive gases of gunpowder. There remains the potash, which combines with the sulphur and yields an inert ash. It is evident that we could obtain similar impulsive gases by the combustion of a number of inflammable substances allied to saltpetre or to some other agent of oxygen. Berthollet proposed to substitute chlorate of potash for saltpetre. This powder, composed of chlorate, sulphur, and charcoal, in the proportions of ordinary gunpowder, did indeed possess a power at least twice that of powder made with saltpetre, but it was too fine and exploded too quickly. It was tested at Essonnes in the month of October, 1788. Scarcely did the pestle touch the substances, when a terrible explosion shattered the mortar and killed several people. We may imagine that it was thought best to renounce such a dangerous agent. But many experiments were made with others. The "white powder," for example, was made of 50 parts of chlorate, 22 of prussiate of potash, and 28 of sugar; but the greater part of these mixtures offered serious inconveniences, and have been quickly forgotten. Thus there has been only one explosive substance discovered for full a hundred years, and this one led to a considerable progress in the manufacture of small arms in allowing them to replace the old flint lock with percussion-caps.

In the middle of the eighteenth century the chemists—among others Nicholas Lemery, and Bayen, apothecary-major of Louis the Fourteenth's armies—had succeeded in preparing metallic mixtures endowed with very energetic explosive properties. They did not dream of immediately utilizing them, and it was only subsequent to the labours of Berthollet, Vauquelin, Fourcroy, and Howard, that percussion powder became the object of industrial study. Long, indeed, were the pages needed to chronicle all the victims who entered into these researches; no substance has so often opened the doors of a laboratory to the messengers of death. The reason of this lies in the fact that the fulminating powders are the products of such an instability that sometimes the slightest friction suffices to cause an explosion, and that this explosion is, in its furious violence, vastly superior to that of ordinary gunpowder. They renounced the silver fulminate as too dangerous and too costly, but they have always made a great use of the fulminate of mercury, a white powder obtained by dissolving mercury in nitric acid, and by adding certain proportions of alcohol to the mixture. This manufacture requires the minutest precautions. They prepare the fulminate only in very small quantities, they only handle it with sticks of soft wood, or pasteboard ladles, and bottle it with extreme circumspection. Mixed with saltpetre, the fulminate of mercury constitutes "Howard's powder," which has replaced the priming powder of the old fusees. It was placed at the bottom of the caps invented in 1818 by the armourer Eggs, and this was the starting-point of the percussion gun.[1]

The fulminate of mercury is still employed in the preparation of certain well-known toys, such as the fulminating peas which explode beneath the feet, Cossack bonbons or crackers, &c.

The fulminates offer us an example of explosive substances which are not mixtures, but defined chemical bodies, which are decomposed by explosion. The number of these substances has been singularly multiplied during the last fifty years, while chemists have done their best to exhaust the truly inexhaustible varieties of combinations which are capable of supplying bodies not foreseen by Nature. Fulminate of mercury, chlorurate, and iodide of azote, present the twofold inconvenience of being very costly and extremely dangerous to handle; for these reasons there has never been any question of substituting them for ordinary gunpowder. It is not the same with regard to another explosive product, rich like the preceding in azote, known among *savans* under the name of *pyroxylin*, and to the public as gun-cotton or explosive cotton. When, in 1846, the celebrated Bâle chemist, Schönbein, revealed for the first time the properties of this singular body,[2] it was certainly believed that powder and saltpetre had had their day. More extensive study, and a more consummate experience of the explosive virtues of gun-cotton, were not long in moderating these early hopes. Schönbein prepared his pyroxylin by keeping the cotton soaked for about a quarter of an hour in a mixture of sulphuric acid and nitric acid, and by then washing it in pure water, and drying the fibres with many precautions. The cotton, thus prepared, did not change much in outward appearance; it preserved its fibrous texture, its consistency, and its colour; but a profound modification had taken place in its intimate structure. Ordinary cotton is a hydrate of carbon, that is to say, a compound, represented by carbon combined with the two elements of water—oxygen and hydrogen. Cotton treated with sulphuric acid has a composition totally different. It has borrowed, and fixed, a great part of the oxygen and the azote contained in that acid, and it is this condensation of an enormous volume of elastic fluids in a small space that is the true reason of the properties peculiar to explosive substances.

From the time of these first experiments, gun-cotton appeared very superior to ordinary gunpowder in regard to energy and inalterability. Unfortunately fire-arms could not resist its strength; it sorely tried, often deteriorated, and sometimes burst the most solid and ponderous gun. Used under the form of ovate, or wadding, as a mining powder, it displayed many advantages, and enjoyed, for a certain time, considerable demand. The terrible accidents to which, more than once, it gave rise in the factories where it was prepared, speedily stifled the use of it, and it was on the point of being completely abandoned, when the researches of Baron de Lenk in Austria, and those of Mr. Abel in England, brought it again before the notice of engineers, for serious and altogether novel reasons. Baron de Lenk supplied the means of manufacturing it with less danger, of purifying it with more success, and of employing it with greater safety. He made his gun-cotton in the form of a compact cord, perforated through the centre, and capable of being easily cut so as to supply the wants of the miners. Numerous experiments executed in Austria with this perfected gun-cotton established its superiority over the same bulk of ordinary gunpowder, without

[1] With 1,250 grammes of fulminate, made from one kilogramme of mercury, we can manufacture 10,000 percussion-caps. Each cap contains three centigrammes of fulminate of mercury, and about one centigramme of varnish covering this salt. The priming of needle-guns is differently composed.

[2] Long ago a French chemist, Braconot, had seen that by treating starch with nitric acid, its nature changed, and it became inflammable. Before Schönbein, Pelouze also had prepared gun-cotton, but without recognizing its properties.

taking into account the advantage it possessed of burning without smoke and leaving no residuum. Some few years afterwards Mr. Abel made decided progress in this industry, by reducing the fibres of the gun-cotton into a pulp, and then converting this pulp by heavy pressure into homogeneous and compact masses, of a density almost double that of the cord.

Nearly all the explosions of gun-cotton have been caused by the spontaneous decomposition of the substance on account of some interior re-action, the nature of which is not yet known, and which consequently it was altogether impossible to foresee and prevent. Among the accidents coming under this category, we may cite, as a notable instance, that of the 14th July, 1847, when the factory of Bouchet, near Corbeil, exploded. They had prepared there 1,600 kilogrammes of gun-cotton, which four workmen were busy in packing in barrels, when the magazine exploded. The workmen were killed. The building, the walls of which were from 50 centimetres to one metre thick, was destroyed from top to bottom; and the ground was furrowed up for some distance to a depth of more than 4 metres. The staves and hoops of the barrels had completely disappeared. 164 trees situated round about were either torn up or shattered, some at the level of the soil, others at different heights. Those nearest were stripped of their bark, and splintered, even down to the roots, into long filaments. Fragments were found as far off as 300 metres.

In the preceding year the factory of Dartford, in England, where they were making gun-cotton after Schönbein's concession, was blown to pieces and twenty persons were killed.

The use of gun-cotton for artillery, thoroughly repudiated by the War Offices in France and England, had a more favourable reception in Austria. The experiments of Baron de Lenk decided them to construct cannon appropriate to the employment of this new agent, and in 1855 the Austrian artillery possessed five batteries of guns fitted for gun-cotton, well equipped and quite ready for service. However, and probably on account of some administrative impediments, none of these cannon were sent to Lombardy at the beginning of the war of 1859. The superiority of the French rifled guns during that campaign excited the emulation of the Austrian artillerymen, and they were on the point of despatching three batteries of gun-cotton cannon to the field of military operations, when the peace of Villafranca cut the experiment short.

Cotton is not the only inert substance to which nitric acid is able to communicate a formidable activity. All the world now knows that liquid, unctuous to the touch, sweet to the taste, limpid and innocent, which is called glycerine. When they make soap by mixing neutral fatty matters with potash or soda, they provoke the decomposition of these fats on the one part into solid fatty acids which combine with the potash or soda—the combination being soap—and, on the other part, in glycerine. Now in causing the nitric acid to re-act upon the glycerine, they convert this liquid, incapable of noise or evil, and much employed in perfumery, into a yellow oil, corrosive, extremely venomous, and endowed with a prodigious explosive power. It was an Italian chemist, Ascagno Sobrero, who, in 1847, discovered nitro-glycerine, the most formidable of all the rivals to gunpowder. It is enough to strike an anvil where only one drop of this nitro-glycerine has been placed with a hammer to produce a detonation comparable to that of a fowling-piece.

Until the year 1863 the product prepared by Sobrero was never brought out of the laboratories, and even there it was regarded as a very dangerous curiosity. At this time M. Noble, a Swiss engineer, was struck with the idea of using it for blasting purposes in mines. At first he impregnated grains of gunpowder with it, which he then fired in the ordinary way. Little satisfied with this result, he sought for other means of exploding the nitro-glycerine, and after many attempts he saw that the simplest and most efficacious plan consisted in employing it in a strong cap, the shock and temperature of which transmitting itself to the nitro-glycerine, assured the complete combustion of the whole mass. Henceforth this yellow oil took rank, in mining industries, among the most powerful explosive agents. In Sweden, in Germany, in all countries, nitro-glycerine became an important article of manufacture. Unfortunately it was impossible either in preparing it on a large scale, in handling it in the magazine, or in exposing it to the shocks of a long journey, to avoid the consequences of the instability often produced. In fact, serious accidents due to nitro-glycerine were very numerous between the years 1863 and 1867. Some time since, a chemist in London, wishing to try the explosive force of this liquid, exploded with a blow from a hammer a drop that was placed some metres distant from a jar which contained a much stronger quantity. The shock was communicated to the jar, the whole contents of which exploded. The laboratory was blown to shivers, and they never found any vestige of the unfortunate chemist. Almost at the same date two carts, each of which was drawn by one horse, and attended by two men, were transporting nitro-glycerine to a slate quarry in the neighbourhood of Carnarvon, in Wales. An explosion occurred, which annihilated everything—carts, men, horses. The road was found to be blasted into two large and deep craters for several metres. One day in the month of June, 1868, there arrived at the quarries of the MM. Zaman, at Quenast, a village situated some leagues from Brussels, a cart laden with 2,000 kilogrammes of nitro-glycerine. The owners always kept this product in a large magazine two stories high, where they stowed away as much as was necessary for their mining purposes. The horses were unharnessed, two men assisted by the escort were occupied in emptying the hampers which contained the cases, when a terrible explosion was heard which shook the ground for three leagues round. The air was traversed by a furious heat which twisted the trees and stripped them of their leaves, and laid low the crops for some considerable distance; the houses round about were shaken to their foundations, the roofs were shattered to fragments; of the huge magazine, nothing but the bricks were left. When they were able to approach the spot where the explosion had taken place, they could find no traces of the cart, or the people who a moment before were surrounding it. They saw instead a gaping gulf, fifty metres from that the bodies of the two horses, pierced through with iron rods, the orbits of their eye-sockets empty. A tailor, who lived about two hundred metres from the place where the accident occurred, declared that he neither heard nor felt anything; only he and all his family were discovered in the cellar of the house, without in the least knowing how they had been hurled into it. The following day an inquest was held, and Christian burial was given to the human fragments they were able to gather up in a basket.

The terrible propensity of nitro-glycerine to decompose, and the almost invincible difficulty of handling it without danger, would have compelled the engineers to have entirely renounced its use, had not a means been recently discovered of suppressing all these inconveniences. This very simple means, discovered by M. Noble in 1867, consisted in mixing nitro-glycerine with an inert matter readily absorbing the liquid. The preparation thus obtained preserved the explosive energy of nitro-glycerine without retaining its extreme irritability.

This paste received the name of dynamite. Originally M. Noble manufactured it by mixing intimately 75 parts of nitro-glycerine with 25 parts of a kind of white earth, porous and siliceous, composed of infusorial fossils, which is found in large quantities in Germany, especially in Hanover, where they call it *kieselguhr*. The open grains of this powder absorb the nitro-glycerine perfectly, and retain it by capillary attraction. At the first fabrication it is true that the nitro-glycerine appeared to have a tendency to separate itself from the silicate, but they soon saw that they had only to submit the unctuous mixture of these two ingredients to a proper pressure, in little parchment cartridges, to obtain a stable and homogeneous composition, capable of being packed and transported without any chance of explosion. Since the invention of dynamite many experiments have been made with a view of modifying the nature or the proportion of the inert matter employed by M. Noble. During the siege of Paris MM. Girard, Millot, and Vogt gave their minds to the serious study of the subject. They recognized that the aluminous and siliceous precipitates, sugar, and several other substances, could be used instead of the white earth of Hanover, but this was acknowledged superior over all other metals in the facility with which it absorbed and retained the nitro-glycerine. Among the many other modifications of dynamite, we may cite a mixture called *lithofracteur*, not so rich in nitro-glycerine as dynamite, and containing nitrate of soda, sand and wood sawdust, with a little sulphur. This preparation has for some time past been the subject of experiments in Germany and England.

The introduction of dynamite into France dates from the end of the year 1870, being indeed caused by the war. Several dynamite factories were improvised during the siege of Paris, at Grenelle, at La Villette, at the Carrières d'Amérique. These factories produced in the month of December 300 kilogrammes a day of dynamite, possessing all the properties of Noble dynamite. At the same time the *Comité de défense* besieged at Tours ordered the establishment of a dynamite factory at Paulille, in the Eastern Pyrenees. At the end of November the factory was in full activity, and at the close of the year 1871 supplied about 15,000 kilogrammes of dynamite per month; and at the present time turns out a larger quantity still, for the use of the Minister of War, as well as for the purposes of trade.[1]

[1] The general consumers of the dynamite manufactured at Paulille are the mine-owners and contractors for tunnels and submarine works in France, Italy, Spain, and the French colonies in Africa.

The dynamite manufactured at Paris during the siege, and at Paulille during the whole of the latter period of the war, rendered important services in the defence. Among the most useful applications to which it was put, we may mention the freeing of the flotilla of gunboats frozen up in the ice in the Seine, near Charenton. It was clearly seen that the ordinary means of setting the fleet at liberty would have been too long and too costly; the river was frozen for a distance of more than 1 kilometre, with heavy lumps of ice heaped and melted together from the surface to the bottom, a depth of some 3 or 4 metres; with pickaxes and levers, judging from the futile results of the first attempts, a period of three months would have been required and an outlay of 200,000 francs. The desired result was, however, obtained in a few days, and at a minimum of expense, by the explosion of dynamite simply laid upon the surface of the ice. The detonation displaced the mass and separated the lumps of ice, and the work was completed by clearing a passage with the prow of a little steamer. Nor was dynamite less precious for the military operations, properly so called. Ingenious use was made of it at Drancy, and on the plain of Arron in destroying the houses by the ramparts, and other buildings where outposts of the enemy were installed. At Buzenval it enabled our troops to blast huge breaches in the walls behind which the German troops were intrenched.

This new agent is as susceptible of employment in the works of peace as in those of war. We have recently witnessed a striking example of the assistance it can render railway work in the construction of the line from Montpellier to Rodez. A tunnel had to be bored on the line at Saint-Xist through the hard Jura limestone. The work in a short time became so obstinate that with the employment of ordinary blasting-powder neither the bore nor the gallery advanced. However, the other works approached completion, the term of the contract had nearly expired, and they began to foresee the moment when the difficulties of finishing the tunnel would prevent the opening of the line. They had then recourse to dynamite. As soon as the workmen had acquired some skill in the use of this agent the progress rose to 30 centimetres a day for the bore, and to 1 metre 30 centimetres in the gallery. For a short period, owing to some block on the railway, a considerable supply of Noble powder was delayed; they were reduced to continue the work with ordinary powder. Then the daily advance fell to 8 centimetres in the bore and 30 in piercing the gallery—this, too, with an equal staff of men. In the cuttings and the tunnels of Cerbère, on the Port-Vendres section by the Spanish frontier, across the Albère slates, the contractor, on the strength of the test-borings made for the directors by the company's engineers, consented to undertake the work at a considerable reduction from his estimate. Having, however, found that the rocks were harder and the work much more difficult than the borings had led him to believe, he was on the point of abandoning the labour altogether and of claiming an indemnity, when the employment of dynamite totally changed the condition of work.

The ease and facility with which dynamite dislodges and shatters hard rock gives a new future to many metallic beds, untouched hitherto on account of the enormous cost of the manual labour they would require. M. Dumas and M. Henri Saint-Clair Deville have noted the importance that will be found for the development of French metallurgy in undertaking, with the aid of Noble powder or dynamite, the exploration of many metalliferous lodes, particularly the rich mines of tin recently discovered by M. Moissenet in Lozère. Another loss that dynamite allows us to avoid is that in the enormous blocks of cast-iron, now out of use, such as the anvils of steam-hammers, and the huge cylinders of rolling-mills, which they were obliged to put on one side on account of the cost of labour necessary to utilize them. Nothing at present is easier than to reduce them to fragments capable of being carried away and re-melted. M. Champion, in a workshop at Maubeege, effected the breaking up of the anvil of a steam-hammer, weighing 5,000 kilogrammes, with only 150 grammes of dynamite.

In the course of the month of January, 1872, M. Paul Barbe, artillery officer, and M. Brüll, civil engineer, made a series of experiments at Fort Montrouge, in the presence of the Emperor of Brazil, which perfectly demonstrated the energy and the many advantages of dynamite. A cubic block of forged iron, weighing nearly 300 kilogrammes, was pierced with a little hole, into which was introduced about 100 grammes of dynamite. After the explosion the hole was very much enlarged, and four fissures existed in the mass. The hole was filled a new with dynamite, and the second explosion settled the rupture of the block into six fragments, of which one was projected a distance of some twenty metres. A barrel, or tun, bound with iron, of two hectolitres cubic measurement, was placed upright and filled with water; it was then pierced in the upper part with a square hole, into which a packet of four cartridges of dynamite, fitted with fuses, was introduced. After the explosion they found no trace of the tun, but the ground where it stood was torn up for a depth of 40 centimetres. Some enormous trees were then cut down, stone walls were laid low, rails and sheets of forged metal broken into many fragments, all with relatively feeble charges of dynamite.

They then thought of charging shells either with dynamite or compressed gun-cotton, but experience proved that here these products are more than defective. On account of the shock of the discharge the shell burst too soon, sometimes even in the throat of the gun itself, which it damaged; at other times the detonation is so violent, that the projectile is reduced to small fragments, and thus passed to the four winds of heaven without doing much harm. We have, then, still to seek for the explosion of shells an agent stronger than ordinary gunpowder but less shattering than dynamite or gun-cotton. It is probable that a compound fulfilling this condition will be met with in the group of explosive substances derived from picric acid, of which we have still to speak.

Picric acid is a crystalline and bitter product, extracted from coal-tar, and which, in combination with potash, forms picrate of potash, a yellow salt, extremely explosive. Mixed, on the one hand, with saltpetre, on the other with chlorate of potash, this salt is the base of the powders manufactured for the first time by M. Designolle and by M. Fontaine. In France these compounds have for some time been the objects of investigations pursued at the offices of the army and navy, and M. Designolle had just received instruction from the government to make picrate powder at the manufactory of Bouchet, when the explosion of a barrel of picrate of potash in M. Fontaine's magazine aroused the indignation of the whole Quartier de la Sorbonne, and put an untimely end to the experiments. We do not rightly know how the picrate was ignited in this instance. In ordinary conditions picrate powder is not more inflammable than gunpowder. It explodes under the influence of a violent shock suddenly applied in a certain manner. The explosive power that it developes, especially when it is compressed, as it would be in a shell or a torpedo, is superior to that of mining powder, inferior to that of dynamite or gun-cotton.

In the month of April, 1868, an experiment was made with a torpedo charged with picrate of potash powder in a creek in the Isles of Hyères. The torpedo, containing 500 kilogrammes of powder, was sunk in the sea to a depth of 7 metres, about 60 metres from Point Leaube. At a given signal the torpedo was fired by an electric spark; then the sea was raised in the form of a spherical cap, some 2 metres high by 30 metres round. A cone of water was thrown 50 metres into the air, taking some sand and the cast-iron case with it, accompanied by a quantity of seaweed for a great part of the height. The persons assembled at the edge of the Point felt a violent commotion, and the crew of the vessel "Louis XIV.," who were at sea about 900 metres distant, felt shocks almost as strong. Any ship which had happened to have been above that torpedo would have been infallibly shattered and sunk.

Dynamite and gun-cotton are as yet the two preparations out of all explosive substances most economical and most convenient, with the further advantage that in them a greater bulk of active force sleeps in the smallest volume; but each of them has advantages and inconveniences which are not found in the other, and which distinguish both from saltpetre powders. Certain it is that to effect the breaking up of hard and resisting bodies, where the employment of sudden force is necessary, dynamite and gun-cotton can be replaced by nothing. If we want to blast very compact rocks, to shatter blocks of very siliceous mineral, to divide enormous masses of iron, these two products render, and will render, precious service. Nitroglycerine congeals very easily, which is a very great disadvantage, for in congealing it seems to acquire a much greater tendency to spontaneous explosion, which is very disadvantageous; it also explodes much more easily than gun-cotton. M. Abel says that a musket ball penetrating into a cart laden with dynamite would determine a violent explosion, while nothing similar would have happened if it had struck a quantity of compressed gun-cotton. On the other hand, dynamite resists the action of water for a sufficiently long time, and may be employed when other explosive substances would lose all their properties. Moreover, it is plastic, that is to say, it can be introduced with the greatest facility into the holes in mines, no matter the shape of the hollows. The rigid cylinders of the gun-cotton do not permit of a similar operation; sometimes even it is arrested by the irregular projection or over-narrowness of the holes; the miner then endeavours to drive the charge home with heavy blows, and an explosion results. It is evident that with a soft substance, accidents during boring ought to be of much rarer occurrence.

Everywhere, then, where very violent action is required the

use of gun-cotton and dynamite would seem to be indicated ; but there are circumstances where these substances are not superior to ordinary blasting powder, if indeed they even equal it, without speaking of the use of gunpowder as a force to impel projectiles. For blasting soft rock, for raising earth, for displacing considerable masses, gunpowder, on account of its progressive action, merits the preference ; its rival powers would shatter, break-up, pulverize everything in the immediate neighbourhood of the charge, but would not dislodge the mass ; and comparative experiments made upon soft rock have established, beyond a doubt, the superiority of ordinary gunpowder in this special case. If, however, the rock is hard, there is a real advantage in combining the use of gun-cotton and dynamite with that of gunpowder. The two first agents, being more violent, serve to prepare the way for the third, which, slower and more measured in its action, heaves up and displaces the materials that the others have shattered and opened out. Those, then, who imagine that dynamite will take the place of mining powder, are clearly wrong. In no place has the consumption of powder diminished since the introduction of dynamite, and in Germany the very contrary has happened. Many beds of metal that had before been contemned, and many abandoned mines, are now being worked, and the simultaneous employment of dynamite and powder evidently creates a new opening for this latter. Thus a concurrence is very often profitable to both.

As a charge for fire-arms, gunpowder retains in the presence of the new comers not only a part but the whole of its ancient advantages. Hitherto we have discovered no composition equal to the old black powder for impelling projectiles without damage to the guns. Still there is ground for believing that as a charge for hollow projectiles—bombs, shells, grenades—and for that of submarine instruments—torpedoes, buoys, &c.—a more powerful and economical preparation will be immediately and definitely substituted for that now in use. Probably for this they will adopt one of the numerous compounds having picrate of potash or picrate of ammonia as a base. These last have already, it appears, done excellent service in pyrotechny. Picrate of ammonia mixed with picrate of iron, nitrate of baryta, and nitrate of strontianite respectively, has served to make rockets of yellow-gold, green, and red, which burn much slower than the ordinary rockets, and with a much more brilliant light.

In a manufacturing point of view gun-cotton is the only substance that can be prepared, so to speak, without any risk of explosion. It can only go off spontaneously at the moment when it is being dried. In the preparation of powders with either saltpetre (gunpowder) or picrate, there is a danger of explosion at almost every phase of the work, starting from the time when the ingredients are first mixed ; and it is the same with nitro-glycerine. The chances of explosion, at present singularly diminished by the care and the precaution they bring to bear upon the manufacture of these products, cannot, indeed, henceforth much cripple the fabrication. The gradual perfection of the processes will cause the reasons and occasions of peril more and more to disappear, and will result either in supplying commerce with products purer, and consequently more stable—for many accidents are due to the impurity of the substances—or in the discovery of means able to diminish the tendency to explosion, without affecting the force of it.[1]

The explosive substances do not present vast differences only under the twofold calculation of the power exerted and the rapidity of deflagration ; but they are still further distinguished by the manner of priming, that is to say, by the means employed for exploding them. Some decompose readily under the action of heat—a temperature of 270° suffices for war powder, and 320° for extra fine sporting powder ; some are kindled by a spark, others, again, require the intervention of the electric spark. In many cases it is true that we cannot clearly discern whether it is the heat or the shock of the explosion of the primer that makes the cartridge go off. Mr. Abel has calculated that the quantity of fulminate of mercury required to explode compressed gun-cotton is more than that demanded for nitro-glycerine ; and that, with the substitution of a prime of nitro-glycerine or iodide of azote instead of the fulminate, we should not succeed in firing the gun-cotton. As to dynamite, which is primed with percussion caps, when it is enclosed in tightly-compressed cartridges it cannot be exploded either by heat, by shock, or by the electric spark. Cold paralyzes the dynamite ; at 10° below zero it is difficult to obtain an explosion. In this there is an indication of molecular actions of different tonalities, if we may so phrase it, and which can be excited only by sympathetic vibrations ; it is necessary that the detonation of the prime should be in unison with the explosive matter. MM. Champion and Pellet have approached this question by direct experiments, which have yielded results remarkably curious though still incomplete. Having placed a little moist iodide of azote upon a double-bass, they obtained an explosion by moving the bow across the higher strings, while the deeper sounds had no influence. They then placed a series of gas-lights, arranged in such manner that they trembled and lengthened into tongues of fire under the influence of determined musical notes ; these are what the physicians call *sensible flames*. By causing various explosive substances, some distance from the instrument, to go off on an anvil, they gathered the fact that nitro-glycerine and the fulminate of mercury give out the whole gamut of sensible flames at five metres, while iodide of azote had no effect upon the flames unless the instrument were brought close to the anvil, and they began by the upper notes. Whatever these differences may be, we cannot refuse to recognize their practical importance.

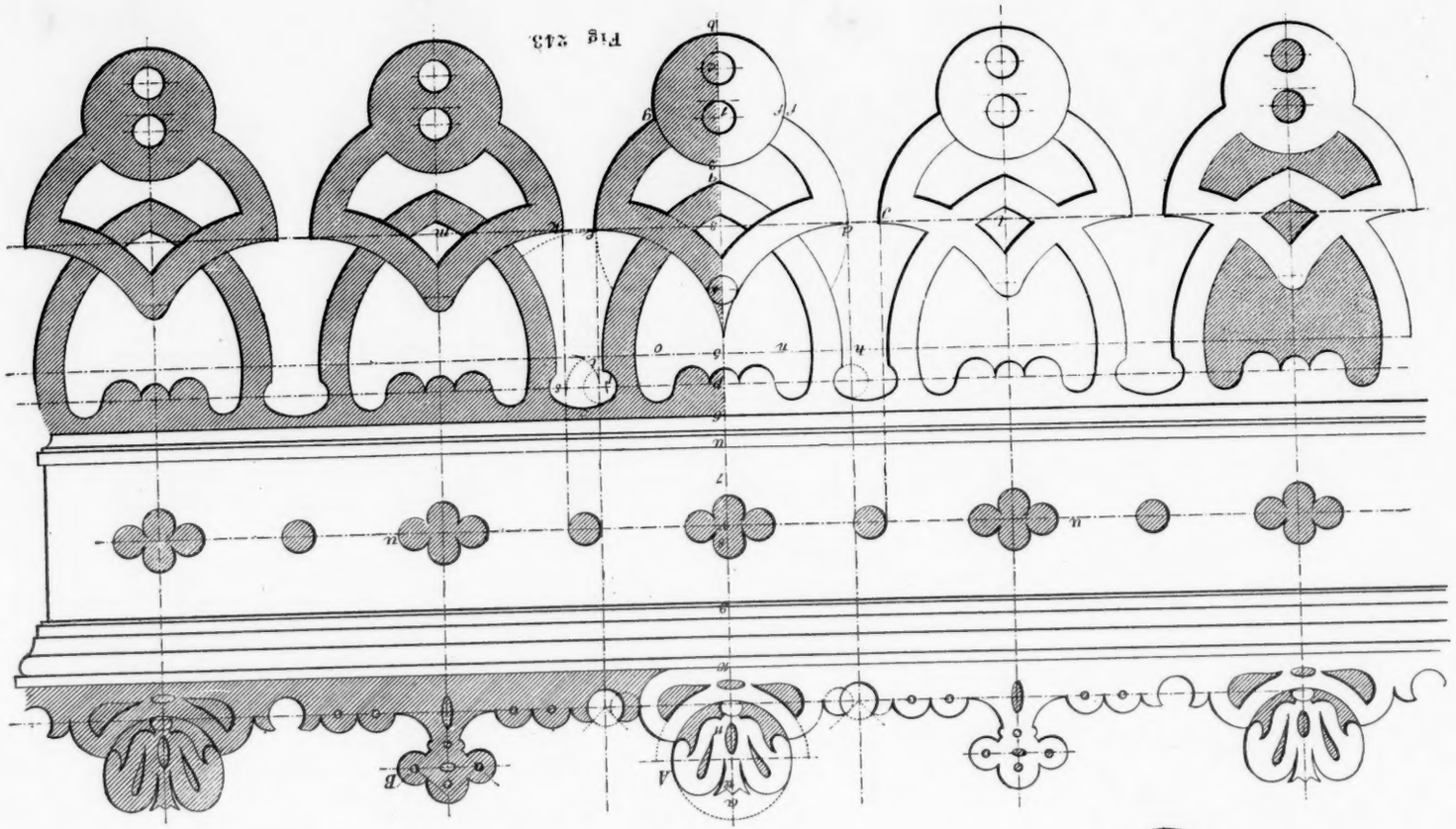
(*To be continued.*)

[1] The "brown-powder" from the factory of M. Schultze of Potsdam, which was tried at Vincennes in 1865, and which is, it seems, only an imitation of gun-cotton—sawdust treated with nitric acid—has the advantages of giving out little smoke and of presenting little danger, for the definite mixture of the ingredients is effected only at the moment of use ; however, it is far from possessing the importance the inventor attached to it.

THE PRACTICAL NOTE-BOOK OF TECHNICAL INFORMATION USEFUL TO STUDENTS AND WORKMEN.

(57.)

DESIGNS for Ornamental Cut Woodwork, with Working Lines and Centres.— In fig. 243 we give a design for a double eaves board, in which *a b* is the height, which divide into twelve equal parts. Give six of these to the lower part of the design, and divide the first part into four equal parts, and from *c* describe the circle as shown. Through the point 3, on *a b*, draw a line at right angles to *a b*, and from the point 3 set off two of the parts on *a b* to the points *d* and *e*. From the points 3 and 1, with radii 3 *d* and 1 *b*, describe arcs cutting in the points *d e* the line *l m*. Through the point 5 draw a line parallel to *d e*, and from *d e*, parallel to *a b*, draw lines cutting the line drawn through point 5 in the points *h* and *i*. From *h* and *i* as centres, describe arcs *d* 5, *e* 5. With the distance *c b*, or *c* 1, set off from *d* and *e* to the points *j* and *k*, and from these set off the distance 3 *e* to the points *l* and *m*, and through these draw, parallel to *a b*, the lines which will be the centre lines of the next adjacent parts of the design. Divide the distances 5 *h* and 5 *i* into two equal parts in the points *n* and *o*, and set off on each side of the lines, *h i*, half of one of the parts, as *b* 1. Divide the space 5 *b* into two equal parts in the point *p*, and through *p* draw parallel to *d e* a line cutting the lines *k i*, *d h*, in points, from which describe circles equal to circle *c* in the space *b* 1. Then from points *n* and *o* as centres, describe arcs as *r q*, meeting in the point *q*. From the point *k* draw parallel to the line *e i* the line *k s*, and from *s* describe a circle equal to that described from *r*. From *r* and *s*, with *r s* as radius, describe arcs cutting in *i*, from *i* describe the arc *t*, joining circles described from *r* and *s*. From the point 6 put in the horizontal lines indicating the mouldings. Divide the distance *u* 9 into two equal parts in the point *v*, and through *v* draw a line *u u*, parallel to *d e*. Through 9 and 10 draw the horizontal lines of top mouldings, and put in the ornaments at A and B as follows. Let *a* 11 and 10 (fig. 243) be points corresponding to similar points in fig. 244. Through 10 (fig. 244) draw a line at right angles to *a* 10. Bisect the distances 10, 11, 11 *a* in the points *c* and *b*, and draw lines through *c* and *b* parallel to *f h*. Let the lines *e f*, *g h*, represent the lines *l* and *m* in fig. 243. From the points *e* and *g* (fig. 244) draw lines at an angle of 45° (by means of the right-angled set square), and from *e* and *g*, with radius equal to two of the parts as *c b* (fig. 243), describe arcs, cutting these lines and terminating at the points as *i j*, fig. 244. From *k* and *l* as centres, with *k i* as radius, describe arcs *l m*, *j n*. With distance *k l*, set off from *n* to *o*, and through *o* draw a line *o p*, and from *o* as centre describe the arc *n p*. From centre 11, with 11 *p* as radius, describe the circle *a*, *p*, 10 *q*. With half of *e l*, from 11 set off to *r s*, and through these points draw lines parallel to *a* 10. Join these lines with the circle as 10 *q*, by parts of circles, as *u*, the centres of which are at *t t*. From centre *w* describe the circle with a radius one fourth of *k l*: do the same at *p* and *q*, and join these by arcs, as *x*, the centre of which is at *y*. Finish as in the diagram, the centre lines indicating the various points. To describe the



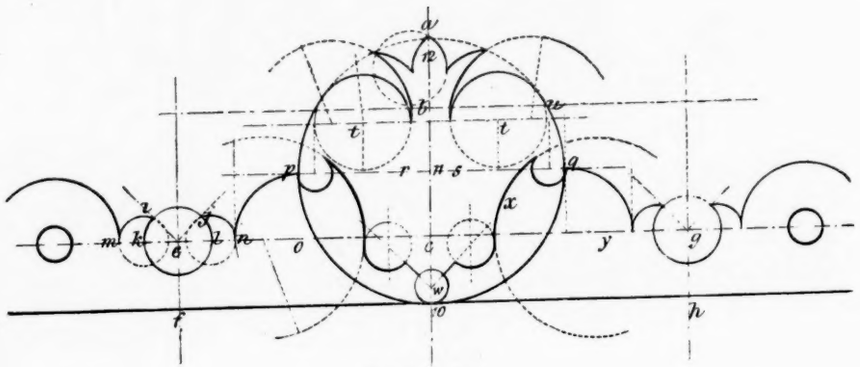


Fig 244.

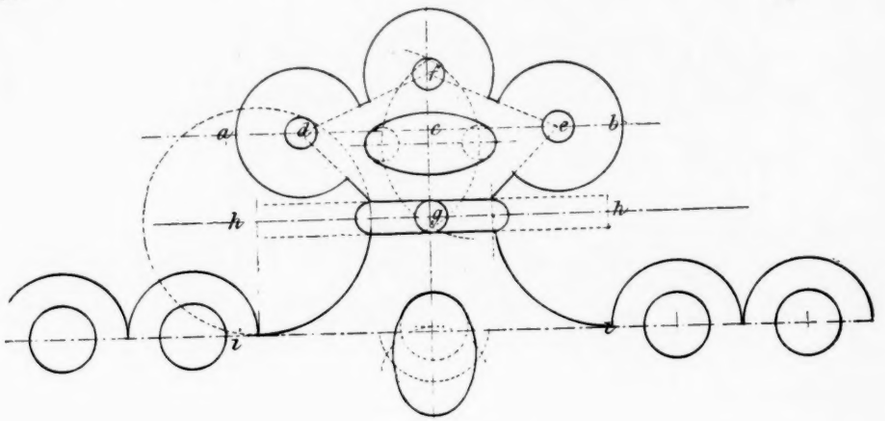


Fig. 245.

part B of fig. 243, let *a b*, fig. 245, be the line passing through the point *b* in fig. 243, and the point *c* be the point of intersection of this with the centre line corresponding to *m* in fig. 243. With two of the parts, as *b* 1 (fig. 243), set off from *c* (fig. 245) to *d* and *e*, and from these as centres, with radius equal to one of these parts, describe the circles as shown. From *c* set off one of the parts as *b* 1 (fig. 243) to *f* and *g*. Draw *e f* and *d f*, and from *f* describe the part of the circle as shown. Through *g* draw *h h*, and put in the part at *g*, and from *h h* describe arcs joining the line *i i*. The centre lines indicate how the remaining parts are finished.

In fig. 246 we give a design for a balustrade or paling, in which *a c* is the height, which divide into thirteen equal parts. Divide the second and third parts into two equal parts in the point *b*, and through *b* draw a line *b d e* at right angles to *a c*. From *b*, with two of the parts as *a c* as radius, describe the circle 4 *f g*, and the inner circle, the radius of which is less than the outer, by two of the six parts, into which the space 1 2 on the line

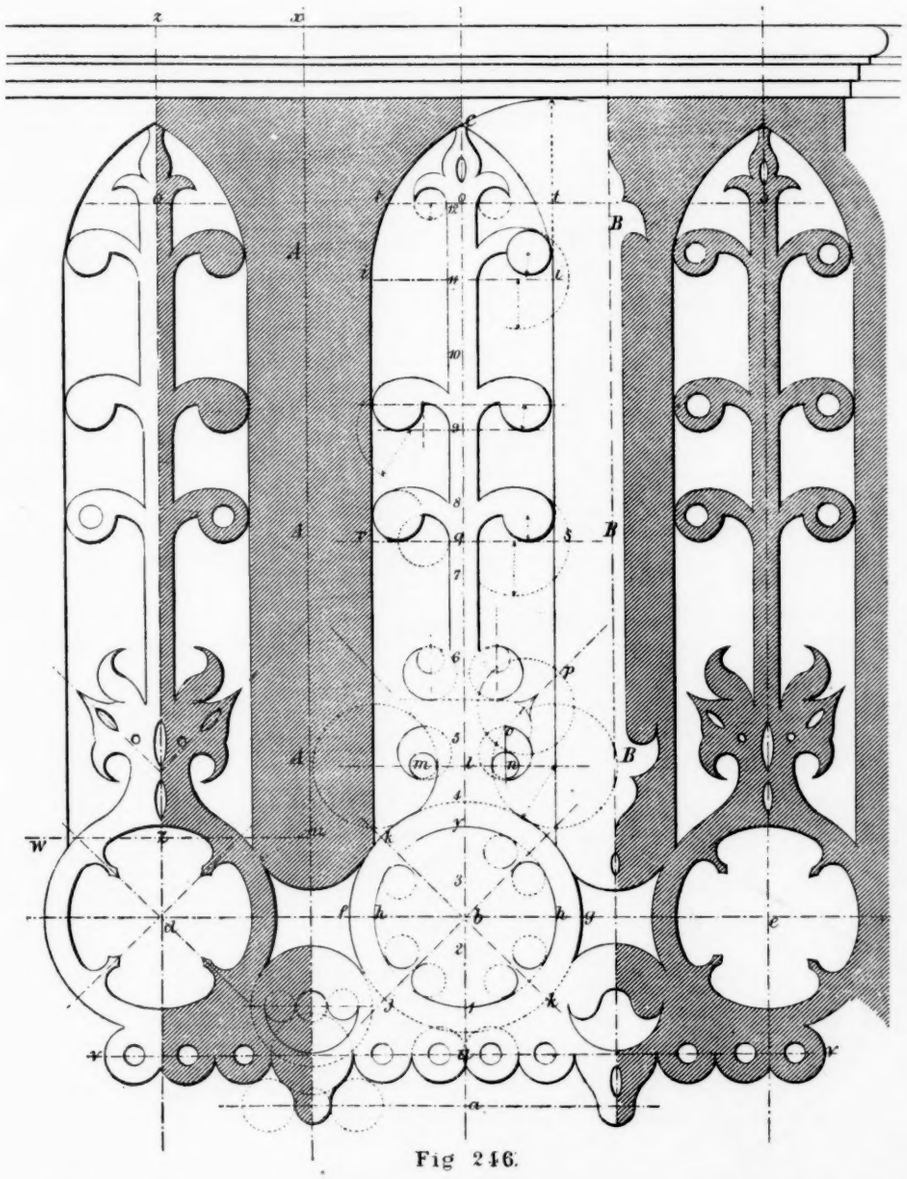


Fig 246.

a c is divided. From the extremities of the radius *h h* of this inner circle draw lines *h i*, *h i*, cutting a line drawn through the point 11, on the line *a c*. From *i i*, with *i c* describe arcs cutting in the point *c*. Through the centre *b* of the circle 4 *f i g*, draw with the set square the radial lines *j b j*, *k b k*. Divide the space 4 and 5 in the point *l*, and through *l* draw the line *m n*. From *m* and *n* draw lines as *n o*, and put in the circle, drawing from *n o* a line *o p* at an angle of 45° with *m n*. Divide the space between 7 and 8 in the point *q*, and through this draw the line *r s*. Through the points 11 and 12 draw lines as *i i*, *t t*. From 1 set off two of the parts as 1 2 to *u*, and through *u* draw the line *v v*. From *k*, with five of the parts on the space 12, set off to *w*, and through *w* draw a line *w x* parallel to *a c*. From *w*, with the distance *w y*, set off to *z*, and through *z* draw parallel to *a c* the line *z z*, which will be the centre line of the next division of the ornament. The various centre lines being thus found, finish as in the drawing. In place of the part A A A being left solid, it may have a part cut out as shown to the right at B B B.

The lower part of the windows on the outside are frequently on the Continent filled in with ornamental wood work, this resting on the sill ; in fig. 247 we give half of a design for this kind of ornament, which may be applicable to other purposes. In this *a b* is the height, divided into nine equal parts ; the depth and breadth of the border is equal to one of these parts. From

c at right angles to *c d* draw the line *c f*, and with the distance *a b* from the point *c* set off to the points *e* and *f*, and through these points draw lines at right angles to *c f*; *f g* is the centre line of the design. From the point *f*, with four of the parts on the line *a b*, set off to the point *h*, and through *h* draw at right angles to *f g*, the line *i i*. From the point *h*, set off to *i i* five of the

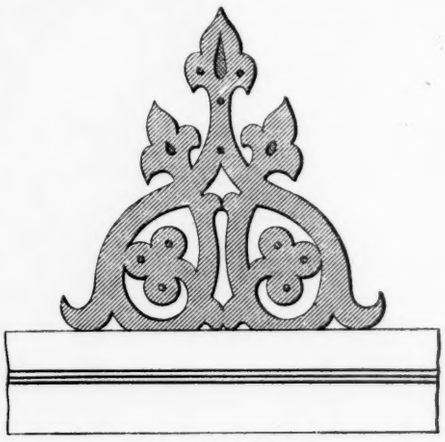


Fig. 249.

parts in *a b*, making *i i* equal to ten of these. Divide *i i* into five equal parts; the first *j* and fourth *k* are the foci of the elliptical ornament, which put in as shown. Through the point 4 on *a b* draw a line 4 *l*, and make the distance *m l* equal to *h i*; put in the elliptical part as shown, and finish as in the drawing, in which all the centres and centre lines are shown.

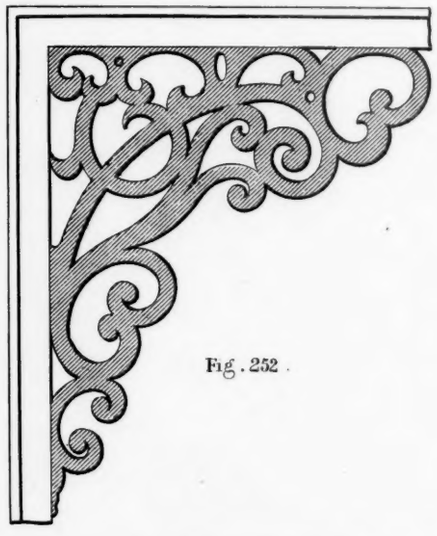


Fig. 252.

As "suggestions" for various parts of cut woodwork, of which we have already in previous "Notes" given diagrams with working lines and centres, and which the student should work out for himself, on the same principles we give sketches as for terminals, for either the upper or lower parts of balconies, &c. &c., as in figs. 248, 249, and 250; for brackets, as in figs. 251, 252, and fig. 253; and panels or centre pieces in figs. 254 and 255.

(58.) **Memoranda on Steel.**—Sir William Fairbairn, to whom the mechanical world is so much indebted for his investigation into the properties of iron, as already stated, has experimented upon varieties of steel manufactured by several companies and firms, and the abstract of these under the various tests we now give as taken from a paper read by him before the British Association, entitled "Experimental Researches on the Mechanical Properties of Steel."

(a.) Strength of Steel to resist Compression or Crushing Force.

Manufacturer.	Weight laid on in lbs.	Greatest weight laid on per square inch of section.		Compression per unit of length.	Value of *n*, or work expended in crushing the bar.
		lbs.	tons.		
Messrs. Naylor, Vickers, and Co.	91,840	225,568	100·700	·286	32,300
Messrs. S. Osborn and Co. . .	91,840	225,568	100·700	·267	30,014
Messrs. C. Sanderson Brothers .	91,840	225,568	100·700	·328	36,906
Messrs. T. Turton and Sons . .	91,840	225,568	100·700	·398	44,888
Messrs. J. Brown and Co. . . .	91,840	225,568	100·700	·347	39,136
Messrs. C. Cammell and Co. . .	91,840	225,568	100·700	·339	38,233
Messrs. H. Bessemer and Co. . .	91,840	225,568	100·700	·379	42,720
The Titanic Steel and Iron Co. .	91,840	225,568	100·700	·315	35,551
The Hematite Steel and Iron Co.	91,840	225,568	100·700	·419	45,813
The Heaton Steel and Iron Co. .	91,840	225,568	100·700	·278	31,391
Mean	91,840	225,568	100·700	·335	37,695

Fig 251

(b.) Strength of Steel to resist Transverse Strain.

Manufacturer.	Mean value, D_1, of the deflection for unity of pressure and section.	Mean value of the modulus of elasticity, E.	Modulus of elasticity, E, corresponding to 1 tn lb. pressure.	Work of deflection, U, up to the limit of elasticity.	Work of deflection, *n*, for unity of section.	Value of C, the unit of working strength.	Mean breaking weight.
						tons.	tons.
Naylor, Vickers, and Co. .	·0013007	30,278,000	29,481,000	66·660	65·049	6·548	1250
S. Osborn and Co. . . .	·0014296	27,482,000	27,540,000	54·150	52·574	5·622	1250
C. Sanderson Brothers . .	·0013209	29,973,000	29,355,000	50·920	47·411	5·521	1200
T. Turton and Sons . . .	·0013120	30,294,000	30,750,000	54·456	52·680	5·886	1000
J. Brown and Co. . . .	·0012739	30,370,000	31,551,000	51·038	52·721	5·918	950
C. Cammell and Co. . .	·0013518	29,166,000	30,690,000	65·059	59·897	5·921	975
H. Bessemer and Co. . .	·0016684	29,810,000	28,673,000	48·404	49·489	5·659	
Titanic Steel and Iron Co.	·0012350	31,901,000	33,088,000	64·168	63·542	6·435	
Hematite Steel and Iron Co.	·0013800	28,754,000	30,772,000	32·928	31·907	4·208	
Heaton Steel and Iron Co.	·0013450	28,603,000	29,285,000	95·080	90·970	7·494	
Mean . . .	·0013611	29,663,000	30,118,000	58·286	56·624	5·921	

(c.) Strength of Steel to resist Pulling or Tensile Strain.

Manufacturer.	Specific gravity.	Weight laid on producing rupture.	Breaking strain per square inch of section.		Elongation per unit of length.	Value of *n*, or work producing rupture.
			lbs.	tons.		
Messrs. Naylor, Vickers, and Co. .	7·8198	39·449	108·099	48·25	·0372	1827
Messrs. S. Osborn and Co. . . .	7·7758	44·131	103·214	46·07	·0341	1842
Messrs. C. Sanderson Brothers . .	7·7563	39·592	95·553	42·65	·0229	1566
Messrs. T. Turton and Sons . . .	7·7990	39·295	93·380	41·61	·0165	807
Messrs. J. Brown and Co. . . .	7·7665	33·603	90·379	40·35	·0460	2002
Messrs. C. Cammell and Co. . .	7·8119	34·085	101·132	45·14	·0595	2714
Messrs. H. Bessemer and Co. . .	7·7726	38·189	89·955	40·15	·0753	3212
The Titanic Steel and Iron Co. .	7·7883	37·179	93·616	41·79	·0551	2413
The Hematite Steel and Iron Co. .	7·7744	33·527	76·550	34·17	·0792	2949
The Heaton Steel and Iron Co. . .	7·8142	44·943	101·513	45·28	·0663	3414
Mean	7·7878	38·399	95·339	42·54	·0492	2274

(59.) **Comparative Values of Wrought-Iron and Steel.**—Sir W. Fairbairn, in the paper above referred to, gives the following under this head :—

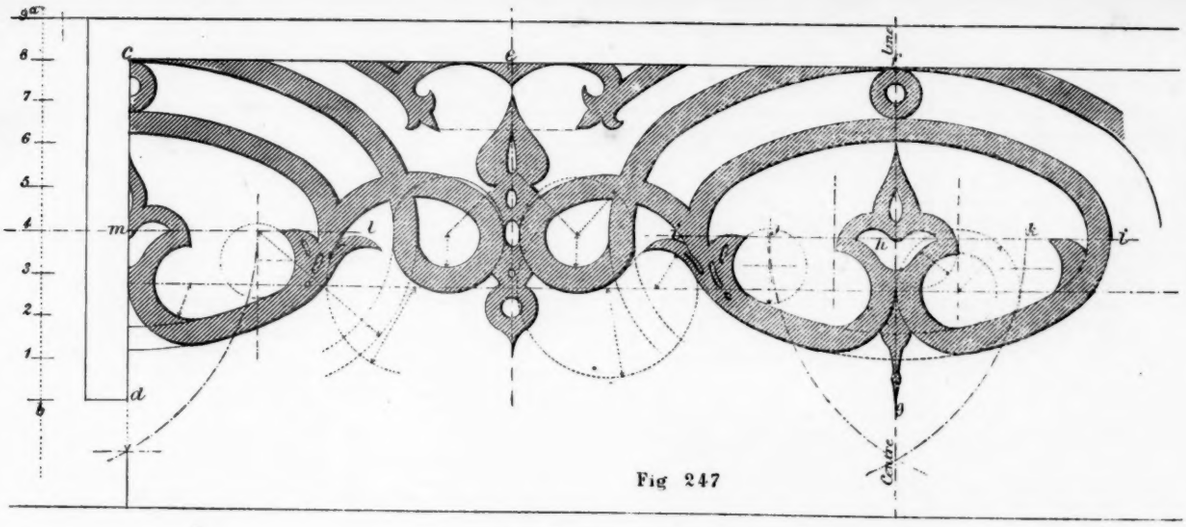
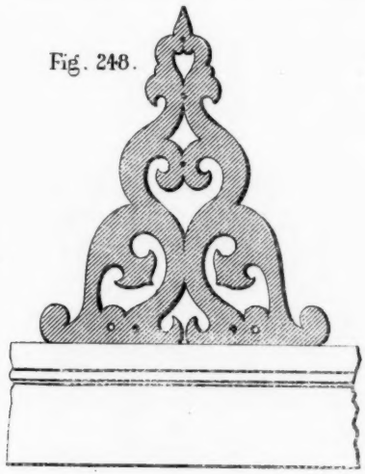


Fig 247

Fig. 248.



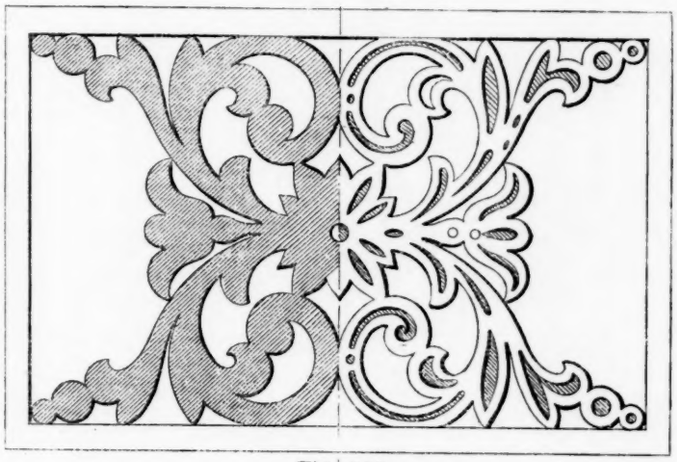


Fig. 255.

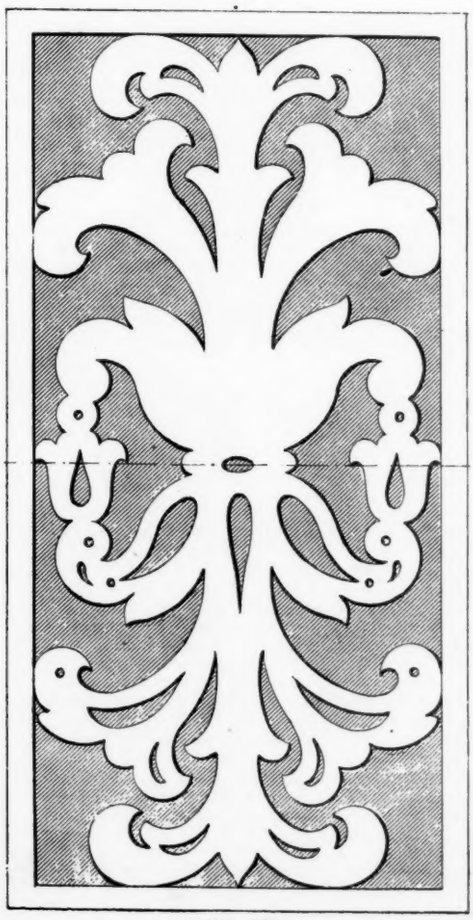


Fig 254

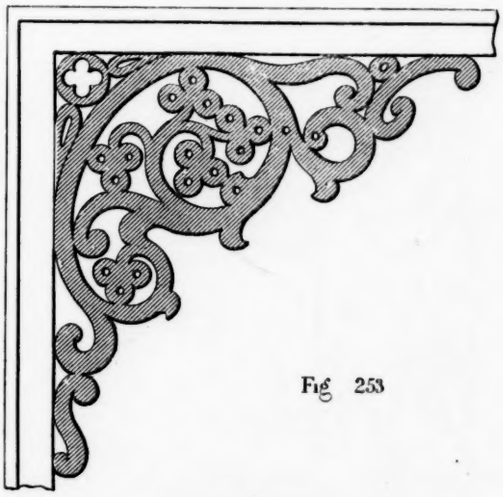
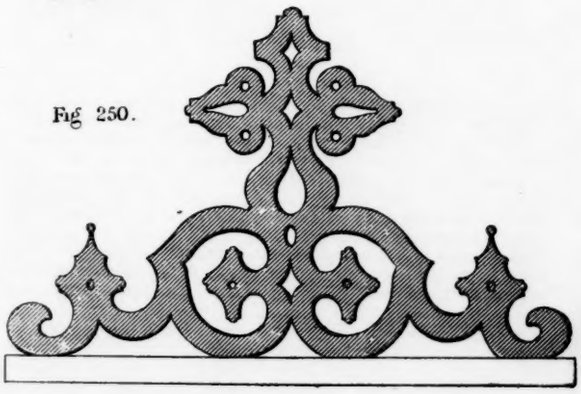


Fig 253

Fig 250.



"The average value of C, the unit of working strength for wrought-iron, is about 2·25 tons, whereas the value of this constant taken for fifteen of the best steel bars, is 7·4 tons, so that the strength of the latter is three and three-tenths times that of the former. The average value, however, of C for the whole of the steel bars experimented upon is 5·172, showing that the average strength of steel in resisting a transverse strain is more than twice that of wrought-iron. The mean transverse resist-

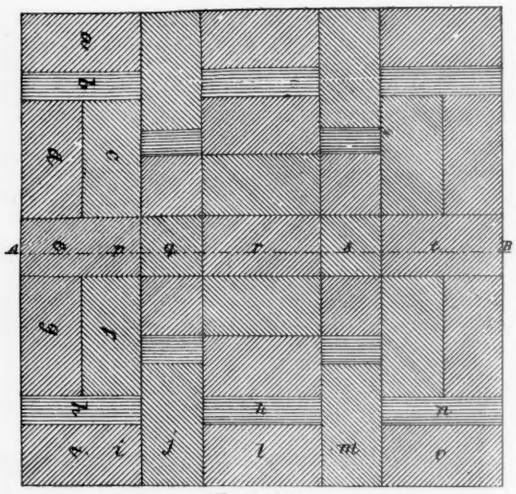


Fig. 257.

ance per square inch for the wrought-iron bars at the elastic limit is equal to 6 D_1, or 6 × 2¼ or 13½ tons, which is somewhat greater than the resistance usually assigned to wrought-iron bars. The average value of D_1 for unity of pressure and section for the wrought-iron bars is ·00167, whereas the value of this constant for the steel bars is about ·0013, showing that wrought-iron bars have a much greater flexibility than steel bars, and, as

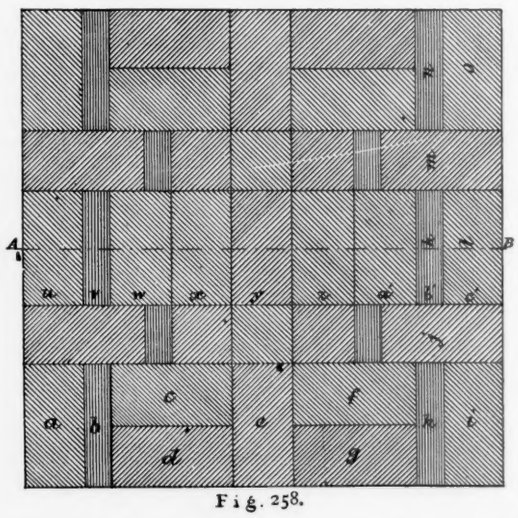


Fig. 258.

a necessary consequence, they have a much lower modulus of elasticity. Under a transverse strain, the work of deflection up to the limit of elasticity is exceedingly low for wrought-iron bars; but the work expended in elongation up to the point of rupture is greater than the average of that determined for the steel bars. This is owing to the *extensibility* of the wrought iron, for whilst the unit of elongation for the average of the steel bars is not quite ·05, that of wrought-iron is ·14, or about three times greater. The same observation applies to the work of compression. The average compression per unit of length is ·45, whereas, for the steel bars, it is only about ·3 of an inch. The average breaking tensile strain per square inch of section of the wrought-iron bars is 25¾ tons, while this average for the steel bars is 42½ tons, showing that the latter are nearly twice as strong as the former. With a strain of 22½ tons per square inch, the wrought-iron bars had not entirely lost their powers of restitution, or the power of regaining to some extent their preceding set.

"Although the short columns underwent a large compression, under the action of compressive force, yet the pressure corresponding to the first visible indication of rupture is considerable, being on an average about 70 tons per square inch, which is about two-thirds of that of hard steel columns."

(60.) **The Student's Sketch Book of Working Drawings.**—In fig. 256 we give elevation of a brick pillar with stone base *a a* and cap *b b*. In fig. 257 we give sectional plan of first course, and in fig. 258 ditto of second course, these courses alternating from bottom to top, as shown in fig. 256. In fig. 259 we give part vertical section of the first eight courses taken through the line A B in figs. 257, 258. In fig. 260 we give an enlarged sub-section of base moulding, as *a* in fig. 256. Figs. 257, and 258, 259, are drawn to a scale twice that to which fig. 256 is drawn. The corresponding letters show corresponding parts in the courses.

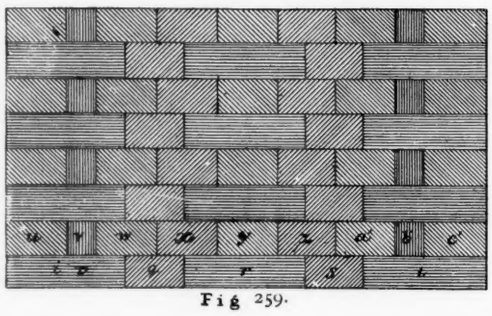


Fig 259.

(61.) **Elementary Notes on Iron Construction.**—Continuing our notes on this subject, we give in fig. 261 the usual method of forming the simplest kind of "built beam" by the aid of angle irons, as *a a'*, *b b'* in section and *h h d* in elevation. The side elevation is at *c c*, *d d*. The beam is made up of a central "web" or flat plate *e e*, provided with a flat "top" plate *f f*, and a flat bottom plate *g g*, these being secured by

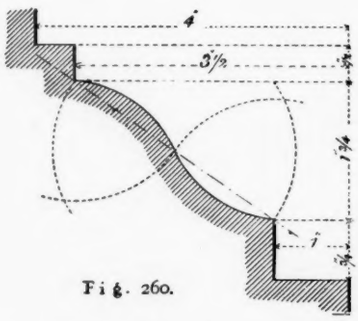


Fig. 260.

angle irons *a a'*, *b b'*—the length of which is equal to the length of the "web" *e e*—to the web by rivets *h h*, *i i*, *j j*.

In fig. 262 we give part cross section—being a little more than one half of the whole depth; *a' a'* being the central line of the depth—of the next form of a built beam which we illustrate, namely, the "box" or "hollow girder," used for wide spans and for supporting heavier weights than the form of plate beam illustrated in fig. 261. In this the box is made up of flat wrought-iron plates *a a a*, *b b b*, of any desired length, and placed apart according to the distance calculated upon; these are parallel to each other, and are kept apart, and the whole arrangement strengthened by the top and bottom plates, as *c c*. In small box beams, one plate, as *c c*, forms the top, a corresponding plate, but which is thicker, forming the bottom plate of the box; but in beams where great strength is required the top and bottom is made up of three or four plates, three in the

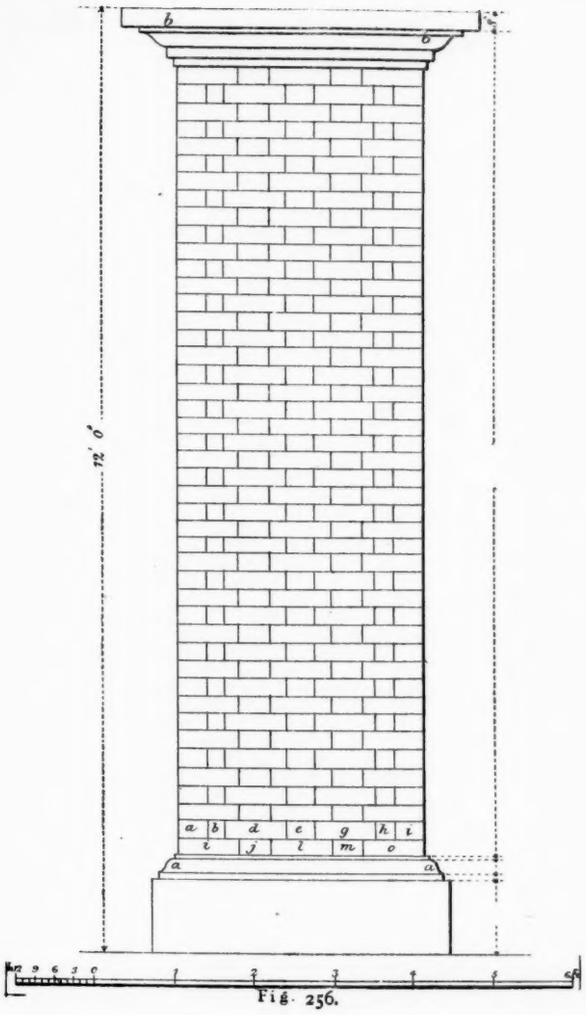


Fig. 256.

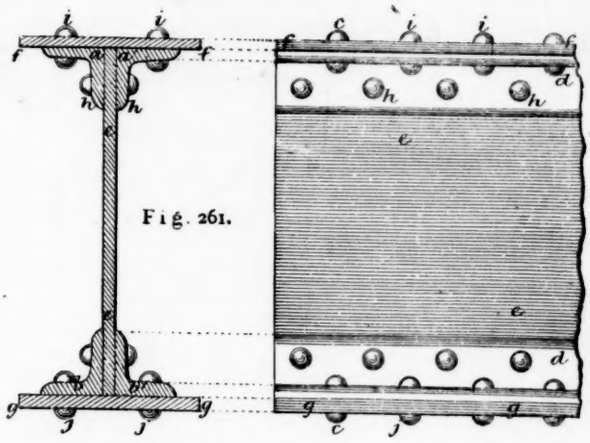


Fig. 261.

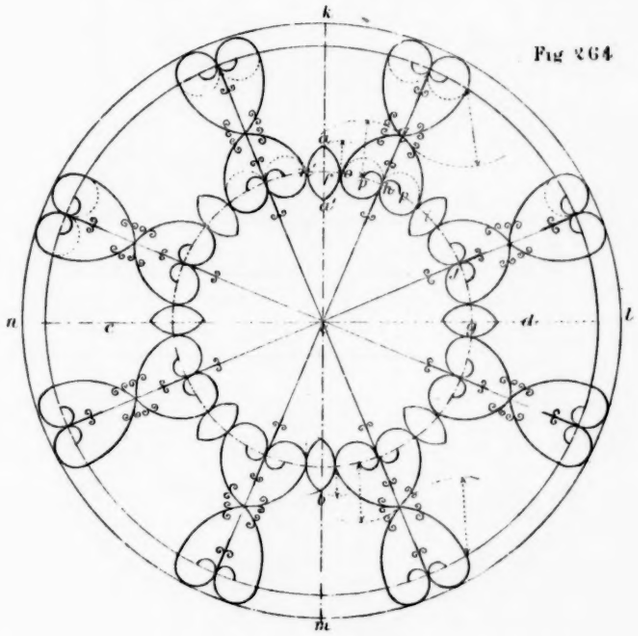


Fig 264

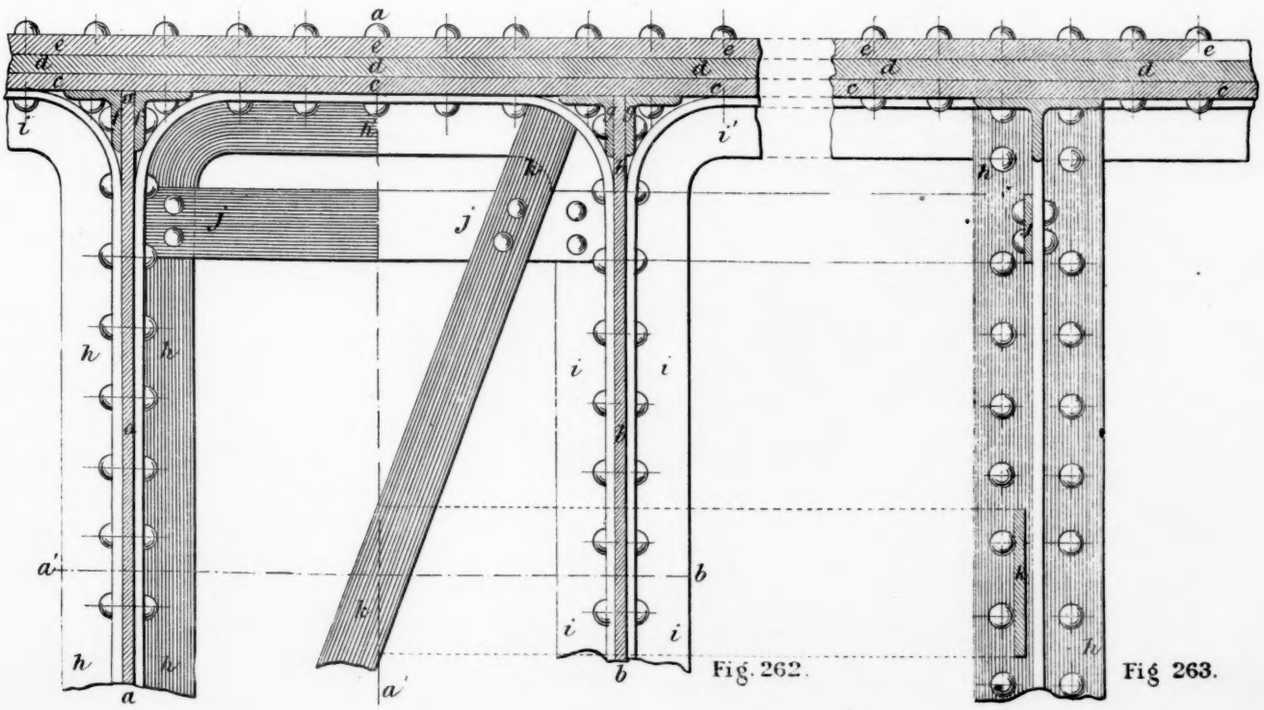


Fig. 262.

Fig 263.

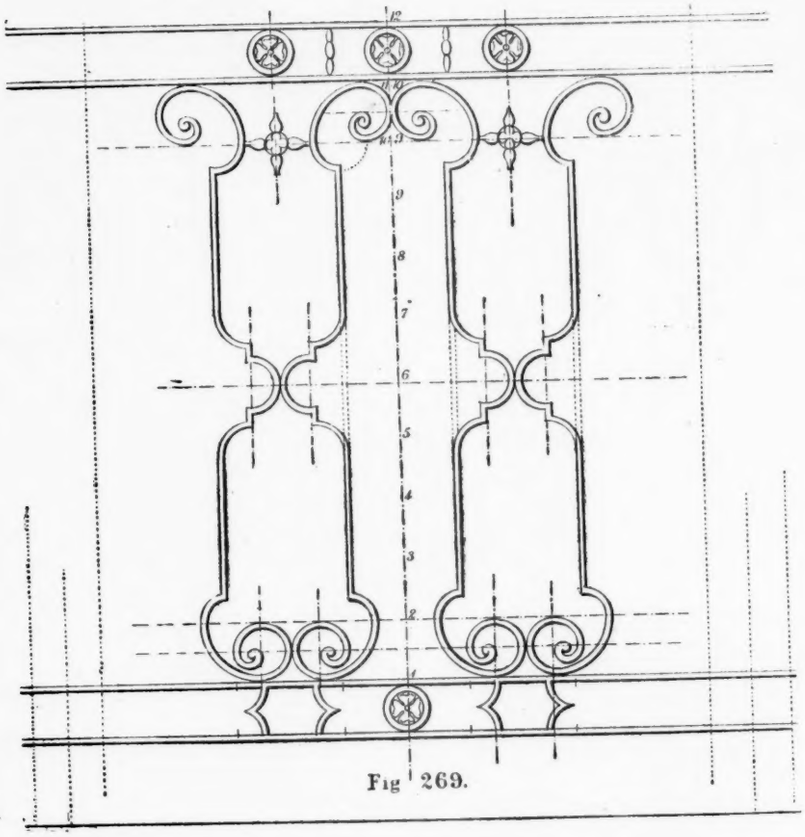


Fig. 269.

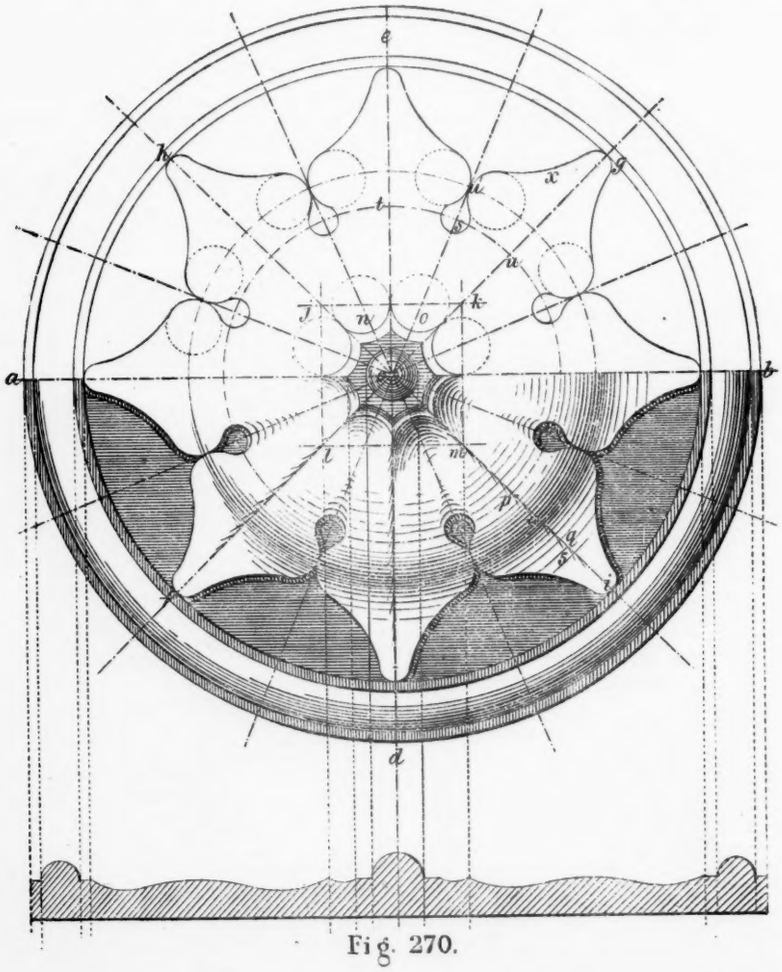


Fig. 270.

illustration, as *c c*, *d d*, *e e*. These are secured to the side plates by angle irons *f f*, *g g*, which run along parallel to, and of the same length as the side plates *a a a*, *b b b*, and top plates *e e e*, *d d d*, *c c c*. At intervals along the length of the side plates *a a a*, *b b b*, strengthening angle irons are riveted, as shown at *h h*, *i i i*. The internal angle irons, as *h h h*, are carried round the whole inside of the box girder, as at *h'*, the external strengthening angle iron *i i* being cut off at *i' i'* flush with the outer edges of the top plates *c d e*.

In fig. 263 we give a section showing the inside of the box girder at the line of the cross and diagonal strengthening bars *j j*, *k k*, in fig. 262.

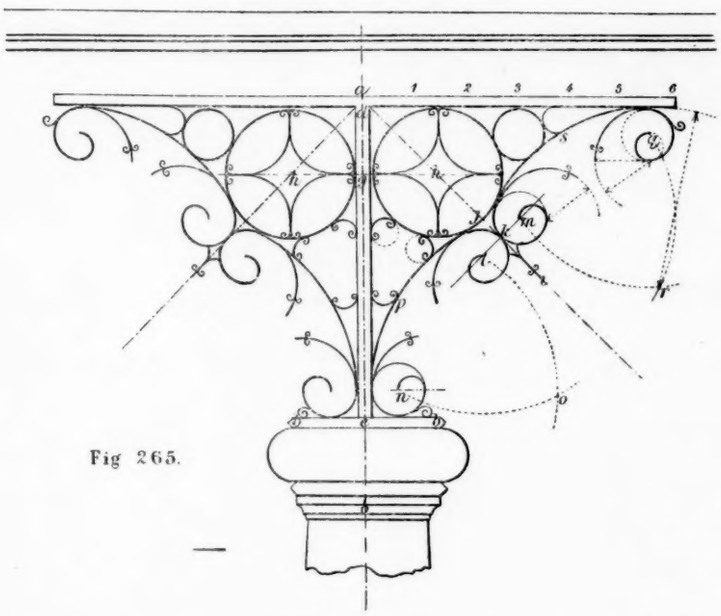


Fig 265.

Sub-section on Iron Construction—Ornamental Work.—In fig. 204 we give a design for a circular ornament for wrought-iron. Draw any two lines, *a b*, *c d*, intersecting in the point *e*; from *e* with any desired radius, as *e f g*, describe the circle as shown by the dotted line. Divide the quadrant *f g* into four equal parts in the points *h h i* and *j*, and through *h* and *j* draw lines continued to cut the other side of the circle, and continued also to cut the outer circle *k l m n*. Divide one of the

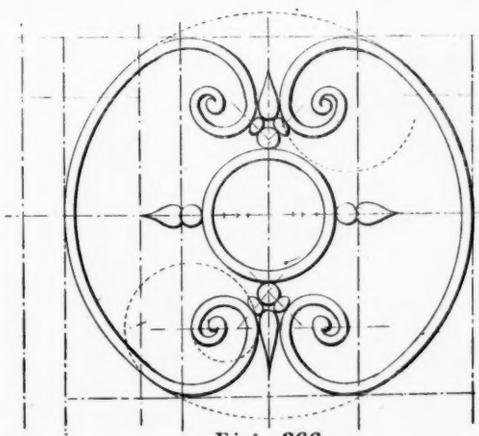


Fig. 266.

parts on the quadrant *f g*, as *f h*, into four equal parts. From the point *f* set off one of these to *n* and *o*, and from *n* and *o* as centres, with *n o* as radii, describe arcs cutting in *a' a*. From a point on the quadrant *f g*, describe an arc, joining *o* with the radial line *e h q*, and *h* with an arc terminating in the point between the second and third divisions on *f h*. From *p p* as centres, with *p o* describe arcs cutting in *q*. Finish the other parts as shown, the centres and radial lines being indicated.

In fig. 265 we illustrate an ornamental wrought-iron bracket. Let *a* 6 be the centre line of column, and *a* 6 the extreme length of bracket. Divide *a c* into six equal parts, and one of these, as *a* 1, into four. Set off one of the parts as *a* 1, from *a* to *d*, and make *d e* equal to *a* 6. Through *e* draw *b e* at right angles to *a b*. With five of the parts on *a* 1 set off from *d* to *g*, and through *g* draw *h g h* parallel to *a c*; from *g* set off the distance *g d* to *h*, and from *h*, with same radius, describe the circle as shown. From *d* draw through the centre *h* of this circle the line *d h i*. With two of the parts on the line *a* 1 set off from the point *j* to *k*, and at right angles to *d h j k*, through *k* draw the line *l m*, making *k l*, *k m*, each equal to *k j*. From the

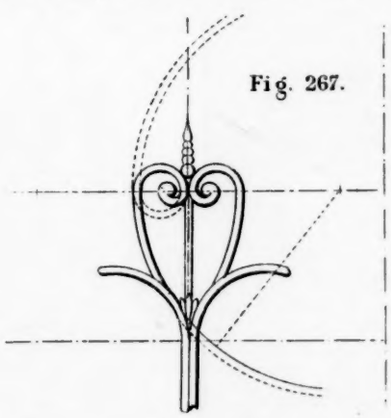


Fig. 267.

centre *n*, with *j k* as radius, describe the arc joining *e b*, *e d*. From the points *n* and *l* as centres, with *n l* as radius, describe arcs cutting in *o*; from *o* as a centre describe the arc *p*, joining the small arcs described from *l* and *m*. The centre, *q*, of small circles at that point is the distance *j k*; set off from the line *d* 6, touching a line dropped perpendicularly from 6. The centre *r* is found by describing arcs from *m* and *q*, and the arc *s* is described from centre *r*. Finish as in the drawing.

In figs. 266, 267, 268, 269, we give suggestions for various forms useful in designing wrought-iron balustrade work, the lines and centres being indicated in each.

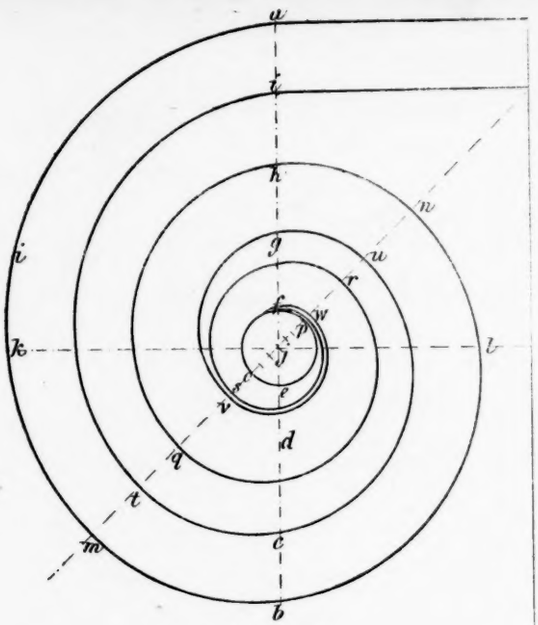


Fig. 272.

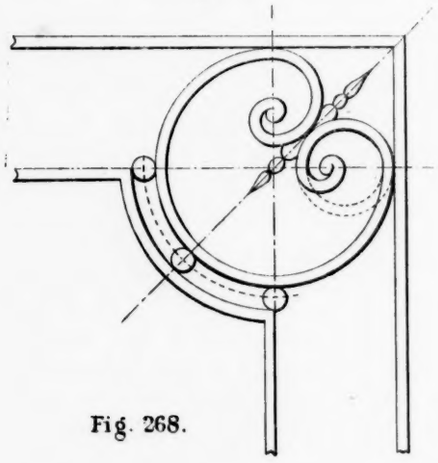


Fig. 268.

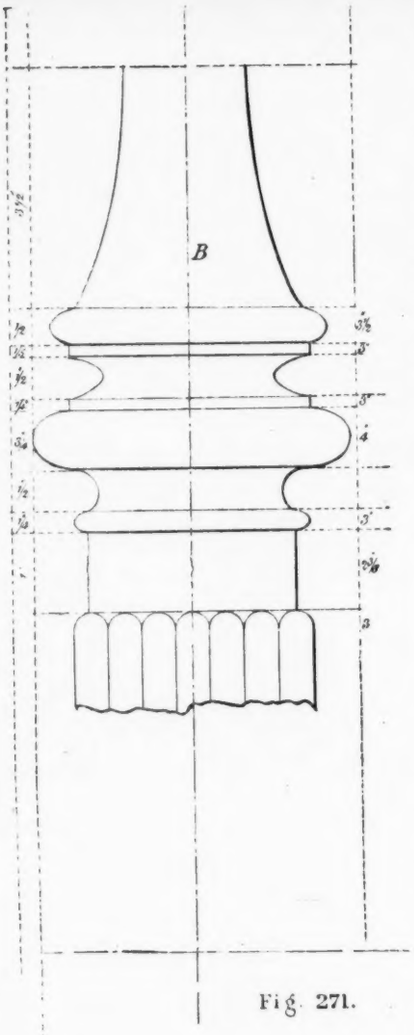
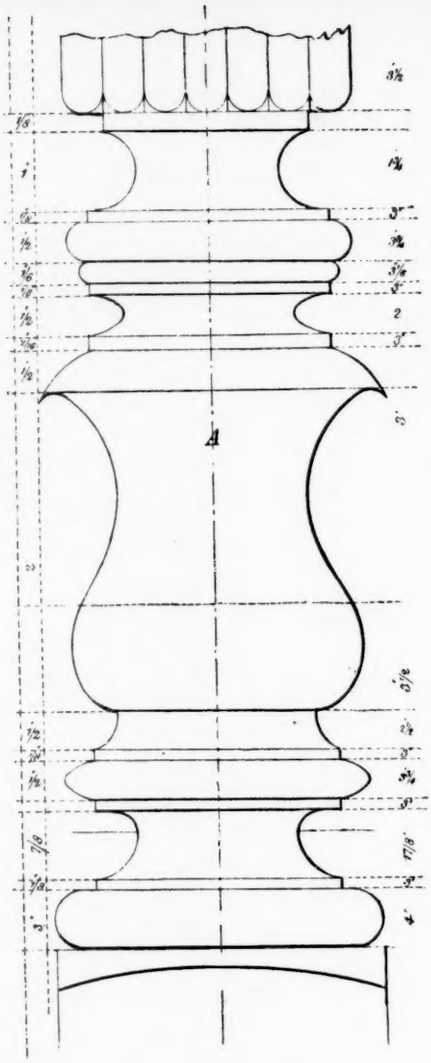


Fig. 271.



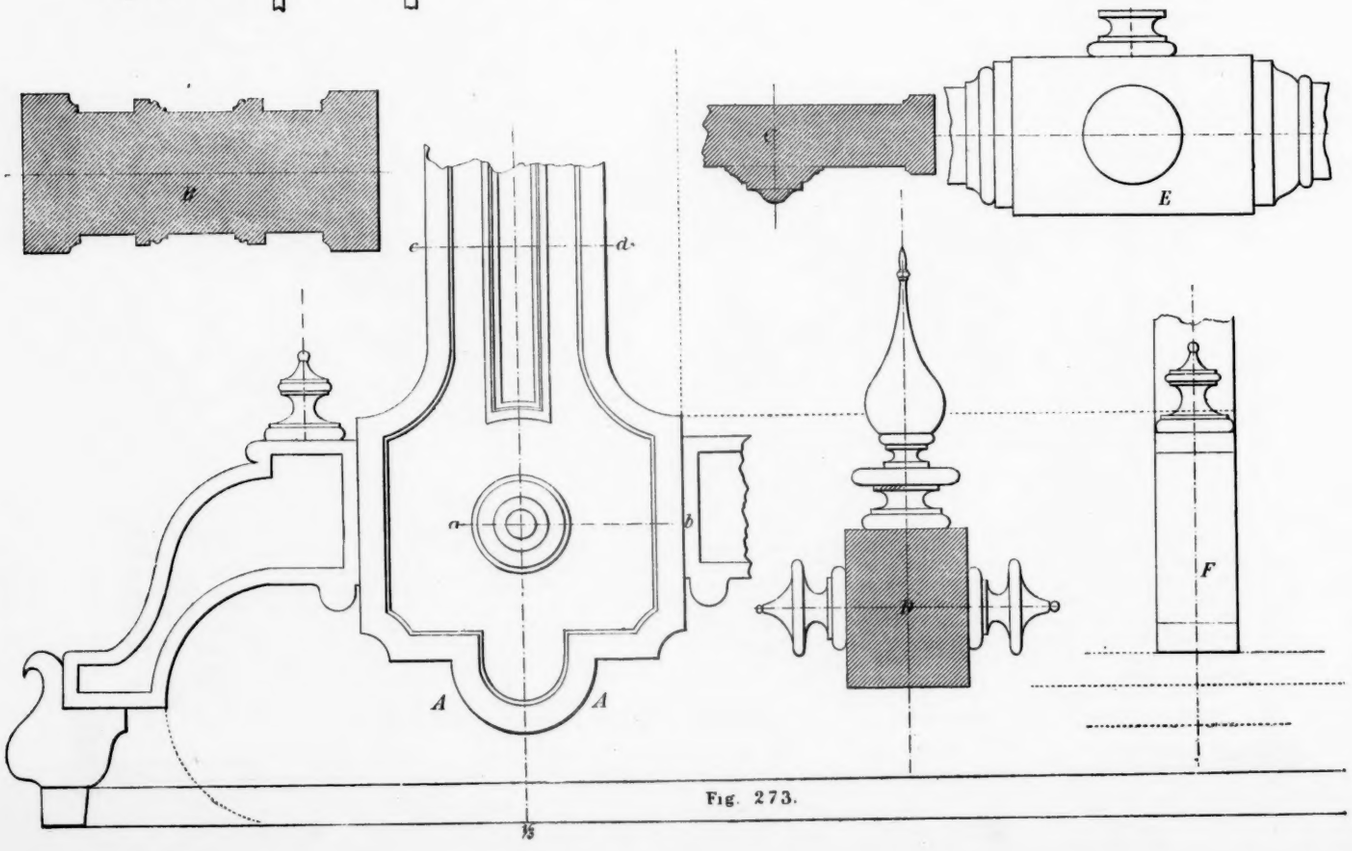
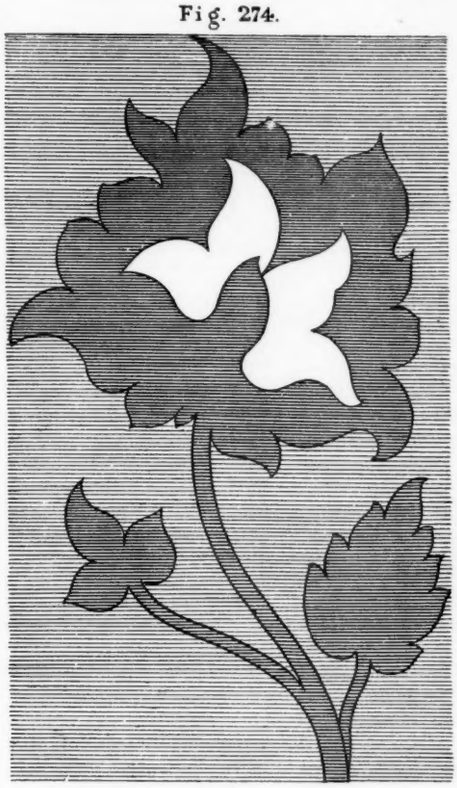


Fig. 273.

(62.) **Elementary Notes on Cabinet-making Design.**—In fig. 238 we gave a design for a centre-piece; in fig. 270 we give another. In this let *a b* be the diameter; divide this into two equal parts in the point *c*, and draw at right angles to *a b* the line *d e*; through *c*, with the "right-angled triangled

Fig. 274.



set square," draw the lines *f g h i*. Put in the small circle at *c*, and the square *j k l m*, and from the centres on the sides of this describe the arcs as *n* and *o*. Divide the distance *m i* into three equal parts in the points *p* and *q*, and from the centre *c*, with

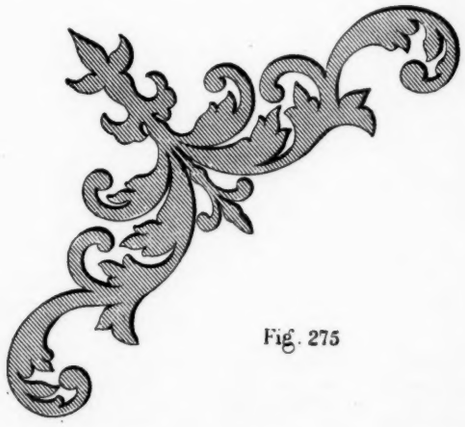


Fig. 275

radius *c p*, describe the circle *p, u, t*. Divide the space as between *t* and *u* into two equal parts, as in the point *s*, and draw radial lines as *c s*, and from the points as *s* describe circles half the diameter of circle at *c*. Bisect the distance *m i* in the point *v*, and from *c* with *c v* describe the circle as *v u'*. With radius of the circle *c*, describe arcs as at *o*, the centres of which are on the circle *v u'*, and which arcs touch the line *c s*. With radius of circle as at *s*, put in semi-circles as at *g*, and join arcs at *u'* with this by a curved line; finish as in the drawing.

In fig. 271 we give a suggestive design for an assemblage of mouldings for a pillar and base A, cap B. We have in former Notes given methods of describing scrolls, in all of which the curves were described by quadrants of circles. In fig. 272 we give a scroll described by semi-circles, which makes

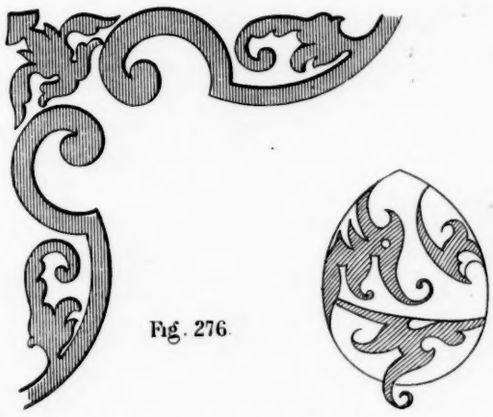
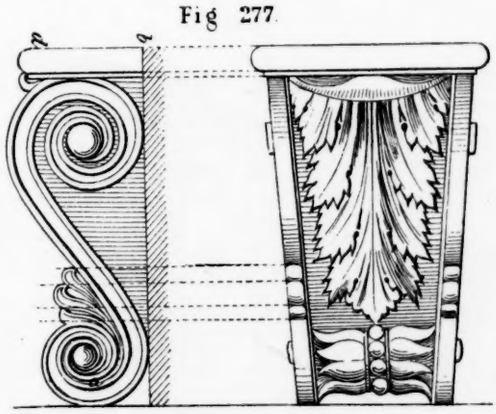


Fig. 276.

the curve produced of an elliptical rather than a circular form. Let *a b* be the height of the scroll, or largest diameter; divide this into eight equal parts, *c d e f g h* and *i*. Divide the third and fourth of these, as *e f*, into two equal parts in the point *j*, and from this as a centre describe, with radius *j e*, the circle *j e*, forming the eye of the scroll. Draw the line *k l*, and divide the

Fig 277.



quadrant *k b* into two equal parts in the point *m*, and draw *m j* produced to *n*. Divide the diameter, as *o p* of the circle *i j* on this line, into six equal parts, then from the point *p*, or sixth point, as centre, with the distance *p l a* describe the semi-circle *a m*, cutting *m n*. Then from the point *o* as centre, with *o m* as radius, describe the semi-circle *m n*. Then from the fifth point in *m o p*, with distance 5 *n*, describe the semi-circle *n q*; then from the point 1, with distance 1 *q*, describe the semi-circle *q r*. From the fourth point, with 4 *r*, the semi-circle *r s*, and from the second point join *s* by an arc with the eye. Next set off from *a* to *i*, and from point *p* as centre, with *p i* describe the arc *p t*; from point *o* with *o t* describe the semi-circle *t u*; from the fifth point in *o p*, with 5 *w*, the semi-circle *u v*; from point 1, with 1 *v*, the semi-circle *v w*; and from the fourth point join *w* by an arc to the eye.

In fig. 273 we give a design for the lower part of a dining or cabin saloon table, in which A is half of the lower part, B section on the line *a b c*, C section on the line *c d*. The two ends of which part is given in A, are joined by a horizontal bar at the level of *a* in A; the centre of this is ornamented as at D, E being an elevation of the front of this. F is part edge view of A.

In figs. 274 to 276 we give designs for "inlaid" work. In a

previous figure, under the head of scrolls and volutes, we have given the method of describing the curves of the scroll as at *a* in fig. 277 ; the illustration in this figure shows its adaptation to a bracket or console ; this may be arranged so as to have the bracket horizontal, the line *b c* being horizontal, *b d* vertical.

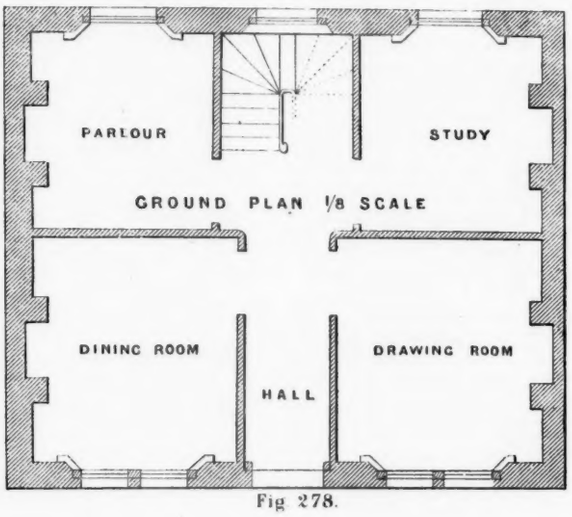


Fig 278.

(63.) **Simple Method of Delineating Architectural Subjects in Perspective.**—In pp. 48, 233, vol. ii., we have given several illustrations descriptive of this method ; we now in continuation of the subject give in fig. 278 the plan of a villa, the perspective of same being taken from the point of sight or angle indicated by block plan in fig. 97, p. 186, note No. 28. Fig. 279 shows the villa as designed in perspective, the lines of which are taken at once from the plan.

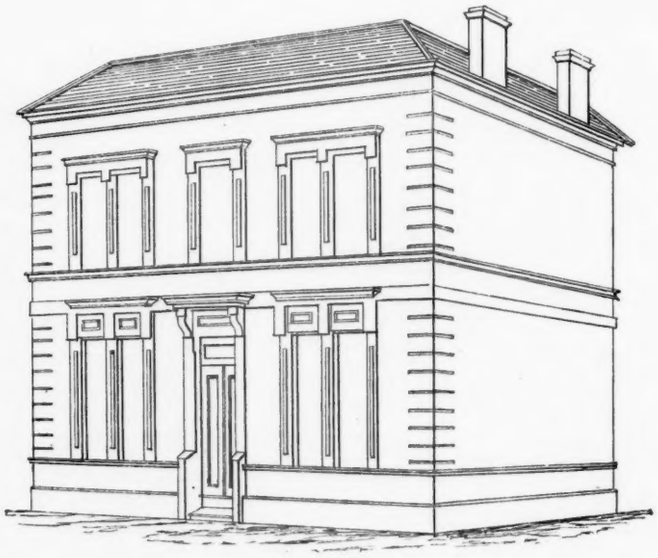


Fig. 279.

WIRE WAYS.

WE illustrated and described in vol. i. p. 334, the main principles of the single wire tramway (Hodgson's patent), as it is being erected and worked by the Wire Tramway Company, 21, Gresham Street, E. C., the main features of which are, as our readers will probably recollect, the peculiar shape of the carrier connecting the load with the box-head which rests on the wire, and which shape enables the carriage or bucket to clear the transoms of the bearing posts, and also maintains the centre of gravity of the load perpendicularly underneath the wire-rope itself; and now we pass on to the consideration of Müller's rope railway, which differs essentially from the Wire Tramway Company's system in as much as there are double, or rather quadruple lines of rope, between each two of which the carriages or trucks run. In his description of this system Mr. H. M. Morrison, the engineer to Messrs. Scott Brothers, the well-known wire-rope manufacturers of Manchester, enters at some length on the history of wire-ways, and seems to consider that the earliest form of them consisted of two parallel tightly-stretched ropes securely fastened at either end, and each rope acting as a single line of rail, along which

ran roller-frames or monkey-carriages, the tubs carrying the load being attached to and suspended from them. To these carriages, or roller-frames, is fastened a light rope running round a pulley at the highest end of the line, the loaded car descending by its own gravity on one rope and pulling up the empty car on the other. In France it appears that this system has been used to some extent, and instances exist where the ropes are stretched across, without supports, a clear space of some 400 or 500 feet. Mr. Morrison further names that this plan was very effectually employed by Mr. Hackney in 1870, when getting out the foundations for the Landore Steel Works (Siemens), in which case the span was 165 feet, the speed of the waggons about 8 miles an hour, and the number passed across daily about 300, each carrying from ten to twelve cwt. of soil, or an average delivery per diem of, say, 165 tons. This appears satisfactory as regards quantity, but unfortunately the data before us does not afford sufficient detail to enable us to form any tangible estimate of the cost.

The second system to which Mr. Morrison refers is Hodgson's, with which our readers are now fully acquainted; and the third that of Herr Müller, to the description of which we purpose devoting this article. After pointing out that under the first two principles of construction it is required as a special condition that the material for transport be carried in boxes or tubs, suitable either for travelling on or being fixed to the ropes, and mentioning that this forms a somewhat expensive feature in the arrangement, when the time occupied in loading and unloading together, especially as regards coal, are taken into consideration as items of cost, Mr. Morrison proceeds to say that in Müller's system this is obviated, as the tubs or trams in use at the collieries and pits can be so arranged as to pass direct from the mine to the wire-ropes, and thus to their destination, without any delay or extra expense for unloading and refilling. The plan by which the vehicles, baskets, cars, and timbers are made to rest upon the ropes is by four claws or notches.

The general character of this double line of rope railway is such as would enable it to be carried across a large ravine, and we apprehend that in all probability the best opportunity for the application of the system will be found in mountain districts, where otherwise expensive bridges, tunnels, or heavy earthworks would be found necessary, the charges for which would frequently be far too great to enable a light traffic to be profitably conducted. It will be understood that this wire railway consists of four lines of endless ropes, one pair being carried perpendicularly above the other, and they are respectively used, the lower for carrying the full trucks and the upper for the return empties. The ropes pass at the terminal points over large driving pulleys, and are supported and guided at certain points by smaller pulleys. The distance from each other of these latter, and their application, depend upon the nature of the ground as well as the weight to be carried, and in many instances the expense of wooden or iron columns or supporting posts may be avoided by taking advantage of the quays and locks which may lie in the line of route.

We now come to the consideration of the motive power, and to the cost of this system of transit. The report which we have before us says, as will be readily conceded, that the motor may be either a steam-engine or a water-wheel, acting only at one end, the large pulleys then being both keyed on to one shaft, whilst at the other end they are separately bedded, and run independently one of the other, each having a tightening apparatus, so as to prevent any unequal stretching of the ropes. Here is a point to which our attention has been drawn by an engineer whose opinion we value highly, and who is one of the few in England who have had practical experience of wire-ways and their working. He takes exception to the double-rope system, because, he says, "it will be found impossible in driving to keep the twin ropes at an exactly equal degree of tension," and points out also that this difficulty would be increased in any cases where the line was carried round angles; for however obtuse these might be, there would be clearly a longer and a shorter radius to the curves of the two lines. Of course, the advocates of the double-wire system argue that the tightening apparatus above-mentioned will obviate all this. We are not, however, quite sure on this head; but, at all events, it is a point which merits consideration, and one which in practice will, we are sure, require very constant care and attention. One somewhat important arrangement we may notice here *en passant;* it is this—the large driving and returning pulleys are lined with wood, which not only increases the grip of the ropes, but the wear and tear consequent on their being driven through iron ones is thereby avoided to a very considerable extent. We may add that the patentees in this country strongly recommend the use of steel rather than iron wire ropes.

We now come to the question of cost, and on this head we are given to understand that the rate per English mile, inclusive of first-class 12-horse-power portable engine, but exclusive of what are called the ramparts or platforms at the ends, is about £1,000, this, of course, being calculated on the present prices of iron, which, as our readers are aware, rule exceptionally high.

In comparing the two systems, double and single rope, we must come to the conclusion that each of them has its separate and distinct advantages and defects; for the single line we may claim that there is less dead weight to be moved, not only as regards the rope, but from the fact of the buckets themselves being so much lighter in proportion to the load than are the wheeled trucks. We are, indeed, advised that 3½ cwt. has been regularly carried in buckets weighing only 90 lbs., which leaves a considerable percentage in favour of carrying capacity of the single wire when compared with trucks weighing 3¼ cwt., and transporting only 8 cwt., as is about the average, we believe, on the double-rope line. Again, for collecting light crops we may claim an advantage for the single wire, inasmuch as where the requirements are only temporary, it is easier shifted than the double one; indeed, Mr. Hodgson has a very ingenious arrangement in this regard, wherein a certain portion of the line leading to the factory or homestead is fixed with a movable radial arm, which is constructed so as to be easily shifted, and which in its action embraces a very considerable portion of surface. On the other hand, as is very forcibly put by Mr. Morrison, there would be a distinct gain in the use of the double rope where coals or other friable substances have to be moved, and we see no reason why the trolleys now running underground should not be easily fitted to work on these lines with but very little alteration or expense. Again, where heavy weight *must* be transported in heavy portions, there is clearly an advantage in the extra strength of the double rope. Here, however, we must leave the question, having, so far as we are able, placed the principles of the two systems plainly before our readers; and those interested in them, or intending to adopt either, must carefully take into consideration their wants, and the general and particular circumstances attending their individual cases, and then decide which wire way is better adapted to their purpose.

SAFETY AT SEA.

ONE of the most important papers recently contributed to science was read at the August meeting of the American Association for the Advancement of Science, at Portland, by Professor William A. Rogers, on the safety of ships at sea. The chief value of the paper was the light it sheds upon the chronometric sources of error on board ship, and the demonstration of the unreliability of all nice determinations of a vessel's position. A few days ago we had the loss of the "City of Washington," without any satisfactory reason for it, while it is certain that had that vessel lost her reckoning and every instrument by which to determine it, her commander might have safely navigated her inshore by the water thermometer and the lead. The time has arrived when navigators sailing on the great thoroughfares of trade, instead of trusting only to the guidance and glimmer of the stars overhead—a dependence which ever fails when most needed, in the hour of storm or fog—should also employ the thermometer, and learn to feel their way in almost perfect security. Franklin, with his great practical mind, discovered nearly a century ago that the seaman, in approaching the American coast, could steer with the greatest certainty in the blackest weather by thermometric tests of the warm Gulf Stream current and its cold counter stream. His friend Williams, who made a sea-voyage from Boston to Norfolk to try the scheme, sailed almost as safely without a compass as with one, and his experience has ever since been cited by the most eminent navigators as conclusive proof of the great value of thermometrical navigation. When the present current charts, accessible to all mariners, are properly studied, they will enable them to mark most clearly the position of the ship when other determination is impossible—as clearly, to use Williams' words, as if "the stripes of water were distinguished by the colours red, white, and blue." But, besides this thermometric guide, the befogged or weather-ridden seaman, when nearing land, has the sounding line to tell him within a few miles just where he is. The splendid researches in the deep sea are rapidly progressing, and are intensely practical, for we may hope they will ultimately give us a photographic chart of the sea bottom, its valleys and its basins, its banks and plateaus, and all its topography, so fully, that a sailing master ought to be able to very nearly tell his position by the lead. Professor Pierce, of the Coast Survey, in

discussing Professor Rogers' paper, argued that soundings, made compulsory by law, will prove the only safeguard of ships, and showed that by the nicest astronomic determinations the navigator may count usually on an error of twenty, and very often as much as sixty miles, without taking into account errors from compass deviation and other sources. The American coast generally shelves gradually into the Atlantic, so much so that our best sailing directions assure the cautious mariner he may, with the lead and chart, find the marks underfoot so plain that he cannot, if he will try them, get unknowingly into the dangers of the shore. The government, through its various well-prepared bureaux, as well as through its Navy Coast Survey, and through special expeditions sent out, cannot too soon begin the work of submarine survey and cartography, and the exploration of all oceanic phenomena, the knowledge of which would make the track of the mariner on the high seas as easy to find as the path of the Western woodsman through the forest after the trees have been blazed by his axe.

ON THE DISTILLATION OF GAS FROM COAL.

THE scientific principles which regulate the distillation of gas from coal have not hitherto demanded that attention which the importance of this branch of technical chemistry undoubtedly deserves. In Scotland the supply of cannel or parrot coal, at a comparatively cheap rate, from fields blindly supposed to be inexhaustible, and in England the intense desire to consider the coke as of equal if not greater importance to the gas, have probably heretofore led scientific as well as practical men to regard this branch of industry as in a sufficiently forward condition, and as quite able to take care of itself. Now-a-days, however, more attention must be paid to the subject. Gas-works are multiplying and extending. The consumption of coal is yearly increasing, and some of our best seams are giving alarming evidence of exhaustion at no very distant day. It behoves us, therefore, to discuss the scientific principles which regulate the distillation of gas from coal, so as best to know whether we are proceeding in the right direction in our every-day work, and whether we are adopting the most economical method of distillation.

For some years we have directed our attention to this subject, and have not only studied the chemistry or scientific part, but, by means of thoroughly equipped apparatus, have been enabled to make a large number of experiments, which have led to important practical results.

The chemical formula for pure wood is $C_6H_{10}O_5$, being 6 atoms of carbon, 10 of hydrogen, and 5 of oxygen; and as each atom of carbon weighs 12, each atom of hydrogen 1, and each atom of oxygen 16, it follows that the actual proportions by weight, in which the elements are chemically united in the wood, are—carbon $6 \times 12 = 72$, hydrogen 10, and oxygen $5 \times 16 = 80$, making altogether 162. During the natural decay of those ligneous and other vegetable matters, which have ultimately led to the formation of our coal-fields, the hydrogen and oxygen have been in greater part, and the carbon in lesser proportion, removed in the form of carbonic acid, CO_2, light carburetted hydrogen, CH_4, hydrogen, H, water, H_2O, &c., leaving the coal with a comparatively greater percentage of carbon than what was present in the original ligneous or vegetable matter. The composition of pure wood and cannel coal, in 100 parts, clearly shows this :—

	Ligneous Matter. Pure Wood.	Average Sample of Cannel Coal.
Carbon . .	44·44	75
Hydrogen . . .	6·17	7
Oxygen . . .	49·39	9
Nitrogen, ash, &c. .	—	9
Total . .	100·00	100

During the distillation of the coal for gas in ordinary retorts there are produced, by the destruction of the coal, a number of different gases and vapours, including heavy carburetted hydrogen, C_2H_4, light carburetted hydrogen, CH_4, carbonic oxide, CO, hydrogen, H, and nitrogen, N, besides other substances which are arrested either in the condensers or in the purifiers. The coal-gas, therefore, as ordinarily used, is a heterogeneous mixture of many different gases, of which the carburetted hydrogens are the luminous members, and the remaining gases are either faintly luminous or are non-combustible. The light-giving carburetted hydrogens are not confined to the two gases which have the chemical formulæ of C_2H_4 and CH_4, but are also present as C_3H_6 and C_4H_8, when they possess even greater luminosity in burning. It is manifest, therefore, that the larger the proportion of the carburetted hydrogens, the greater the photogenic or light-giving power of the coal-gas; whilst when the other gases, such as carbonic oxide, hydrogen, and nitrogen, are present in increased amount, the luminosity of the coal-gas must decrease in a corresponding degree.

During the earlier part of the distillation of gas from a charge of coal in the ordinary retorts, the light-giving carburetted hydrogens preponderate, whilst in the later stage of the process the less luminous gases are present in the greatest volume. It is manifest, therefore, that the first portions of gas evolved from a charge of coal will possess a much higher photogenic power than the last portions. The specific gravity or density of the earlier gas is also greater than that of the later gas, owing to the difference in the respective weights of the various gases which form the heterogeneous mixture known as coal-gas. Thus, taking air as 1,000, the heavy carburetted hydrogen, C_2H_4, has the specific gravity of 978; light carburetted hydrogen, CH_4, 557; carbonic oxide, CO, 967; and hydrogen, H, 069. So that the hydrogen is eight times lighter than the light carburetted hydrogen, and fourteen times lighter than the heavy carburetted hydrogen.

Besides the quality of the coal which is employed in charging the retorts, there are various circumstances which influence the photogenic value of the gas; such as the temperature of the furnace, and the length of time which the charge is kept in the retorts. A low heat leads to the obtainment of a small volume of gas of comparatively high quality, and reduces the proportion of non-luminous gases to a minimum; but such a method of procedure is far from economical, owing to the loss of luminous matter in the distillation of oil, and of vapours which condense either in the ordinary condensers or in the gas-holders and pipes. A high heat, on the other hand, increases the volume of gas at the expense of the luminosity, for it not only adds largely to the proportion of hydrogen and other non-luminous gases, but it tends to decarbonize or withdraw carbon from the more highly luminous gases. Thus heavy carburetted hydrogen, C_2H_4, even when formed from the coal, is reduced to light carburetted hydrogen, CH_4, when allowed to impinge upon an overheated retort, there being at the same time a deposit of the missing atom of carbon in the interior of the retort. Indeed, the undue heating of the gas may cause the separation of the whole of the carbon from C_2H_4 to CH_4, and to H itself, when the carbon is deposited in the retort, and the hydrogen, now expanded to double the volume of the original carburetted hydrogen, passes through the meter and is recorded as gas. It will thus be observed that a low temperature in the distillation of gas is wasteful, owing to the production of oil and condensable vapours, and a high temperature is wasteful, from the decarbonization of the luminous gases. The skill of the gas engineer lies in determining the proper heat which will at the same time prevent, on the one hand, the distillation of oil and non-permanent gas, and, on the other hand, the destruction of the more useful gas.

Even when the proper heat has been commanded there are various suggestive points to be considered; such as the duration of the time of the distillation of each charge, and the most economical way of using coals in mixture or otherwise.

The time during which each charge should be heated in the retort must depend much on the quality of the coal itself, but there is reason to believe that the period might be materially shortened with great advantage to the photogenic or light-giving power of the gas, though at the same time to a loss in the total quantity of the gas. The decrease in volume, however, is mainly in those gases which are faintly or not at all luminous, but which in burning evolve the highest heat. Many experiments were made by us with cannel or parrot coals for the purpose of arriving at correct and trustworthy data as to the difference in the quantity and quality of the gas evolved from such coals, when distilled in long or full-time charges as compared with short-time charges. In both sets of trials the retorts and furnaces were kept as nearly as possible at the same heat, and the only difference in the mode of working was, that, whilst in the long or full-time charges the gas was practically worked out of the coal in the time and manner followed in ordinary gas-work experience, in the short-time charges the gas was eliminated from the coal for a period of time equal to about three-fourths of that which was occupied in the long or full-time charges. In other words, where a charge would be heated for four hours in the long or full-time mode of working, a similar charge was heated only for three hours in the short-time trials, when the operation of distillation was stopped and the coke was withdrawn.

The coals experimented upon were the Haywood cannel coal, the Bank gas coal (both upper and lower seams), the Lochgelly parrot coal, and the Raith parrot coal. The detailed results of the practical trials are given in the following tables, where the

yield of gas in the long-time charges may be contrasted with that given in the short-time charges :—

Haywood Cannel Coal.

	Long-Time Charges.	Short-Time Charges.
Yield of gas from one ton of the coal	11,153 cub. ft.	9,333 cub. ft.
Specific gravity of the gas (air = 1,000)	572	591
Total weight of the gas from one ton of the coal	489 lbs.	423 lbs.
Condensation by bromine = heavy hydrocarbons	15 per cent.	16 per cent.
Durability of the gas — 1 cubic foot burned at a 4-inch single jet	73 min.	76 min.
Ditto, 5-in. ditto	58 „	61 „
Illuminating power of the gas—5 cubic ft. burned during the hour from a No. 5 fishtail or union burner — in standard sperm candles	30·97 candles.	34·87 candles.
Total illuminating power of the gas obtained from one ton of the coal in pounds of sperm	1,178 lbs.	1,144 lbs.

These results show that in distilling the Haywood cannel coal in short-time charges, as contrasted with long-time charges, the yield of gas decreased from 11,153 to 9,333 cubic feet, being 1,820 cubic feet, or 1-6th less gas ; that the candle power increased from 30·97 to 34·87, being a difference of 3·90 candles, or 1-8th more ; and that the total illuminating power of the gas from 1 ton of the coal decreased from 1,178 to 1,144 lbs., being 34 lbs. deficiency, or 1-35th of the whole light.

Bank Gas Coal—Upper Seam.

	Long-Time Charges.	Short-Time Charges.
Yield of gas from one ton of the coal	10,080 cub. ft.	8,516 cub. ft.
Specific gravity of the gas (air = 1,000),	527	543
Total weight of the gas from one ton of the coal	407½ lbs.	3,55½ lbs.
Condensation by bromine = heavy hydrocarbons	14 per cent.	15 per cent.
Durability of the gas—1 cubic foot burned at a 4-in. single jet	74 min.	77½ min.
Ditto, 5-in. ditto	59 „	62 „
Illuminating power of the gas — 5 cubic ft. burned during the hour from a No. 5 fish-tail or union burner — in standard sperm candles	27·67 candles.	31·45 candles.
Total illuminating power of the gas obtained from one ton of the coal in pounds of sperm	956 lbs.	918 lbs.

In this case the Bank gas coal gave 1,564 cubic feet less gas by the short-time charges, which is equal to 2-11ths of the whole yield by the long-time charges ; but the candle power was raised 3·78, or 1-8th more, and the total illuminating power of the gas from 1 ton of the coal exhibited a decrease of 38 lbs., or 1-25th of the whole.

Bank Gas Coal—Mixed Upper and Lower Seams.

	Long-Time Charges.	Short-Time Charges.
Yield of gas from one ton of the coal	10,126 cub. ft.	8,468 cub. ft.
Specific gravity of the gas (air = 1,000)	524	542
Total weight of the gas from one ton of the coal	407 lbs.	352 lbs.
Condensation by bromine = heavy hydrocarbons.	13·75 per cent.	14·8 per cent.
Durability of the gas—one cubic ft. burned at a 4-in. single jet	71 min.	77 min.
Ditto, 5-in. ditto	57 „	61½ „
Illuminating power of the gas—5 cubic ft. burned during the hour from a No. 5 fish-tail or union burner — in standard sperm candles	27·07 candles.	31·28 candles.
Total illuminating power of the gas obtained from one ton of the coal in pounds of sperm	940 lbs.	908 lbs.

The mixed seams of the Bank gas coal thus yielded by the short-time method of working 1,658 cubic ft. less gas, or 1-6th of the total quantity ; whilst the photogenic power of the gas rose 4·21 candles, or 1-7th more, and the light from one ton of coal decreased 32 lbs., or 1-30th of the total quantity.

Lochgelly Parrot Coal.

	Long Time Charges.	Short-Time Charges.
Yield of gas from one ton of the coal	10,040 cub. ft.	8,460 cub. ft.
Specific gravity of the gas (air = 1,000)	515	532
Total weight of the gas from one ton of the coal	396½ lbs.	345 lbs.
Condensation by bromine = heavy hydrocarbons.	11·5 per cent.	13 per cent.
Durability of the gas — 1 cubic ft. burned at a 4-in. single jet	65 min.	70 min.
Ditto, 5-in. ditto	52 „	56 „
Illuminating power of the gas—5 cubic ft. burned during the hour from a No. 5 fish-tail or union burner—in standard sperm candles	26·24 candles.	29·82 candles.
Total illuminating power of the gas obtained from one ton of the coal in pounds of sperm	903 lbs.	865 lbs.

The Lochgelly parrot coal, therefore, gave in the short-time charges 1,580 cubic ft., or 1-6th less gas ; the illuminating power of the gas rose 3·58 candles, or 1-7th more ; and the total light was 38 lbs. less, or 1-24th of the whole amount.

Raith Parrot Coal.

	Long-Time Charges.	Short-Time Charges.
Yield of gas from one ton of the coal	9,630 cub. ft.	8,180 cub. ft.
Specific gravity of the gas (air = 1,000)	511	526
Total weight of the gas from one ton of the coal	377½	330 lbs.
Condensation by bromine = heavy hydrocarbons.	11 per cent.	12·5 per cent.
Durability of the gas — 1 cubic foot burned at a 4-in. single jet	64 min.	69 min.
Ditto, 5-in. ditto	51 „	55 „
Illuminating power of the gas — 5 cubic ft. burned during the hour from a No. 5 fish-tail or union burner—in standard sperm candles	25·61 candles.	29·26 candles.
Total illuminating power of the gas obtained from one ton of the coal in pounds of sperm	845 lbs.	822 lbs.

This coal, in the short-time charges, yielded 1,450 cubic ft., or 1-7th ess gas ; the photogenic power increased 3·65 candles, or 1-7th more ; and the total gas from one ton of the coal was equal to 23 lbs., or 1-37th less than in the trial with full-time charges.

The foregoing results as given in the five different sets of trials may be averaged as follows :—

Average Results of Experiments on Different Coal.

	Long-Time Charges.	Short-Time Charges.
Yield of gas from one ton of the coal	10,205 cub. ft.	8,591 cub. ft.
Specific gravity of the gas (air = 1,000)	529·8	546·8
Total weight of the gas from one ton of the coal	415·5 lbs.	361·1 lbs.
Condensation by bromine = heavy hydrocarbons.	13·05 per cent.	14·26 per cent.

Durability of the gas—1 cubic ft. burned at a 4-in. single jet	69·4 min.	73·9 min.
Ditto, 5-in. ditto	55·4 „	59·1 „
Illuminating power of the gas—5 cubic ft. burned during the hour from a No. 5 fish-tail or union burner—in standard sperm candles	27·51 candles.	31·33 candles.
Total illuminating power of the gas obtained from one ton of the coal in pounds of sperm	964·4 lbs.	931·4 lbs.

From this latter table it will be observed that the average of the five trials shows a decrease of 1,614 cubic ft., or fully 1-6th of the full quantity; whilst the luminosity has increased 3·82 candles, or fully 1-7th more; and the total illuminating power of the gas from one ton of the coal exhibits a deficiency of 33 lbs., or 1-30th of the whole light.

A summary of all these results is given in the following table :—

Summary of Results of Experiments in the Distillation of Gas from Cannel Coals in Long-Time Charges compared with Short-Time Charges.

Name of Coal.	Mode of Distillation.	Yield of Gas from One Ton of the Coal.	Total Weight of Gas from One Ton of the Coal.	Illuminating Power of Five Cubic Feet of the Gas in Standard Sperm Candles.	Illuminating Power of the Total Gas from One Ton of Coal in Pounds of Sperm.
		Cubic Feet.	lbs.	Candles.	lbs.
Haywood Cannel Coal	Long-Time Charges	11,153	489	30·97	1,178
	Short-Time Charges	9,333	423	34·87	1,144
	Difference	1,820	66	3·90	34
Bank Gas Coal, Upper Seam	Long Time Charges	10,080	407½	27·67	956
	Short-Time Charges	8,516	355½	31·45	918
	Difference	1,564	52	3·78	38
Bank Gas Coal, Mixed Upper and Lower Seams	Long-Time Charges	10,126	407	27·07	940
	Short-Time Charges	8,468	352	31·28	908
	Difference	1,658	55	4·21	32
Lochgelly Parrot Coal	Long-Time Charges	10,040	396½	26·24	903
	Short-Time Charges	8,460	345	29·82	865
	Difference	1,580	51½	3·58	38
Raith Parrot Coal	Long-Time Charges	9,630	377½	25·61	845
	Short-Time Charges	8,180	330	29·26	822
	Difference	1,450	47½	3·65	23
Average Results of Five Experiments	Long-Time Charges	10,205	415·5	27·51	964·4
	Short-Time Charges	8,591	361·1	31·33	931·4
	Difference	1,614	54·4	3·82	33·0
		Being fully 1-6th less Volume of Gas.	Being fully 2-15ths less Weight of Gas.	Being fully 1-7th more Illuminating or Photogenic Power.	Being 1-30th less Total Light from One Ton of Coal.

The advantages and disadvantages of working on short-time charges, as compared with long-time charges, may be summed up as follows :—The advantages are, the increase of the candle power of the gas, and the exclusion of a considerable amount of gases which are mainly dilutants of ordinary gas, and which are objectionable owing to the large share they have in the production of heat in our apartments. The disadvantages are, the loss in the volume of the gas, even though it be of a faintly luminous nature, and the deficiency in the total light yielded by the gas from one ton of the coal, even though that amounts only to 1-30th of the whole available light—coupled also with the extra expense of working the retorts. The more the matter is looked at, however, the advantages appear all the more clear and decided. The increase in the candle power will admit of less expensive coals being employed in the distillation of better gas, for the difference in the mode of working insures a rise of nearly four candles in the quality of the gas. The comparatively useless nature of the gases which are excluded may be learned from the fact that, whilst 1-6th of the total volume of the gas is held back, there is only 1-30th less light from the ton of coal. Moreover, the coke of the short-time charges, when withdrawn from the retorts, does not evolve much luminous gas, and it appears well-nigh exhausted of all its light-giving power. We may safely, therefore, affirm that the distillation of gas from coal by short-time charges is to be commended, because of the better quality and increased luminosity of the gas, and the comparative exclusion of gases which are more heating than luminous in their nature. These results point to the general use of gas with the greatest amount of pleasure and benefit to the consumer, and probably also from the possibility of employing cheaper qualities of coals, to the pecuniary gain of the gas manufacturer.

HANDASYDE'S Composition for preventing Incrustations in Steam Boilers.—A really good composition of this sort, which is at the same time within reach commercially, is a matter of prime importance to the great mass of those who use steam power. We have pleasure in giving place to a report on Handasyde's composition by Mr. James Davidson, C.E., the manager of the Marquis of Lothian's extensive collieries at Newbattle, Scotland. Mr. Davidson says :—"I have employed Handasyde's composition in boilers using pit water; and also in boilers where the water was highly charged with carbonate of lime. I have found that the formation of crust upon the boilers was entirely prevented, and the iron kept clean in every case where I used it. Mr. Handasyde's boiler composition is as effective as any I ever used, and it is the cheapest."

THE "Archimedean" Lawn Mower.—This machine, patented by Messrs. Williams and Co. (Limited), of King William Street, deserves high praise for its mechanical arrangements and thorough execution. We have seen it tried not only on well-kept lawns, but on rough and difficult ground—in both cases with the most satisfactory result. The simplicity of the parts and the non-liability of the machine to get out of order are features which deserve distinct mention.

The American Engineer and Inventor:

SELECT ABSTRACTS OF PATENTS RECENTLY GRANTED IN THE UNITED STATES.

[*For information concerning this department see the notice on the wrapper below the Contents of the Number.*]

108. Improved Sawing Machine.

The object of this invention is so to improve the construction of the saw guide that the stroke of the saw may be rapidly changed and adapted to the requirements of the cutting operations. The increase and decrease of the stroke is produced by simple means, and easily regulated. The invention consists of lever connections, acting on the front and pitman end of the saw shaft, to be operated simultaneously or separately, as desired.

109. Improved Music Leaf Turner.

This invention consists in a series of leaf turning arms arranged loosely on a pivot at the top of a support adapted to rest on the book rack of a musical instrument. On said pivot is a wheel with an arm, which acts against all the leaf turning arms on one side, and swings them round to the side from which the leaves are to be turned, when a lever at the bottom of the support, connected with a segment gearing with said wheel, is pressed down by the player. There is another wheel on said pivot for throwing the arms in the outer direction one at a time, to turn the leaves, when a similar lever at the bottom of the stand, connected with said wheel by a toothed segment, is pressed down. This last wheel is thrown back by a spring, and the first one is turned back by the last when it throws the first arm. The invention also comprises a spring clip for the arms to clip the leaves and hold them so as not to slip out when the arms swing, which is so constructed that it can be opened readily for engaging the leaves by pinching it between the thumb and finger.

110. Improved Cake Pan.

This invention consists of cake pans on frames, in which the pans shall be secured in place firmly and neatly, and in such a way that they can be conveniently cleaned and washed, and that they will not be liable to become loose.

111. Improved Portable Fence.

The object of this invention is to improve what is known as the "worm fence." Triangular shaped posts govern the position of the panels and the shape of the fence. These posts do not extend into the ground, but the rails are fastened to them by a single bolt or pin at each end, so that they will turn on the bolts or pins, and thus give the fence a degree of flexibility for crossing uneven ground. The panels are connected together with iron staples. Two of these staples are usually employed, one near the top and one near the bottom. Keys are driven through them, by taking out which the fence may be taken down, removed, or packed away.

112. Improved Reciprocating Winnower.

The lower grading screen is made in two parts. The upper sections are elevated above the planes of the lower ones, so that the wind from the fan can act with much better effect on the grain, both for separating the oats and other light matters at the upper ends of the upper sections, and the screenings at the point where they are separated. The upper section of the lower screen is made shorter than the upper section of the upper screen, to give the oats a better chance of dropping down. The lower section of the lower grading screen does not extend quite as low down as the end of the upper screen does, and delivers its grain between the partitions of the grain box and the side of the screen box. The upper screen delivers its grain on the other side of partition which separates the grain box from the fan chamber.

113. Improved Evener for Thread.

This invention is an improvement in the class of thread eveners formed of vertical jaws adjustable toward or from each other; and the improvement consists in adapting the jaws to be adjusted independently and also simultaneously, as occasion may require.

114. Improved Corn-planter.

The drive wheels revolve upon and carry the axle with them in their revolution by clutches held up by springs and operated by levers. By suitable mechanism, the said levers may be struck and operated to withdraw the clutches from the wheels by the rear end of the tongue when the furrowing and dropping devices are raised from the ground. To the lower ends of the conductor-spouts are rigidly attached the openers, the rear parts of which are widened and have an opening formed in them directly beneath the discharge opening of the spouts, so that the seeds may be deposited in the bottom of the furrow before said furrow becomes partially filled by the soil falling inward from its sides. The forward parts of the lower edge of the openers are inclined or rounded upward to enable it to pass through the soil and over obstructions more readily. The openers enter slots in the shoes, which are drawn along the surface of the ground, pushing back obstructions and smoothing the said surface. The openers may be adjusted to project below the said drags, according as the seed is to be deposited at a greater or less depth in the ground. To the outer sides of the drive-wheel are attached rings, which are grooved to receive flanges formed upon bars, the centres of which ride upon the outer ends of the journals of the axle, and which are made of such a length that their ends may come in contact with and mark the surface of the ground as the said wheels revolve. The markers are connected with the wheels, so as to be carried round by and with the said wheels in their revolution by set screws, so that the bars may be conveniently adjusted to mark the ground directly opposite the hills.

115. Improved Horse Hay Rake.

This invention consists in an improved horse hay rake, which is so constructed that the teeth may be raised to discharge the hay by the advance of the machine, and may be disengaged automatically and allowed to drop back to the ground when the hay has been discharged. By suitable construction, as the machine is drawn forward, a rod will be revolved. When a sufficient amount of hay has been collected, the lever pawl is thrown into gear with the ratchet wheel. This stops the revolution of the rod so that as the machine continues to advance the rod and axle are carried forward, which raises the teeth and discharges the hay. As the rod and axle are carried forward the projecting end of the lever pawl strikes an inclined arm attached to the foot board, which disengages the pawl from the ratchet wheel and allows the teeth to drop back to the ground, ready to again collect the hay.

116. Improved Cane Stripper.

This invention is an improvement in cane strippers of the class in which a pair of drawing rolls are arranged in combination with a fixed and movable spring stripping blade. A single stack is passed through each hole in the table to the rollers below by the attendant, so as to be seized by them and pulled through while the stripping blades are bearing against them on one side and pressing them against the hole on the other, which strips off the leaves and other substances suitable for fodder, and prevents them from going into the kettle, and saves a large amount of skimming.

117. Improved Brake for Railroad Cars.

This invention relates to a novel and effective brake for railroad cars, designed to operate to a more advantageous degree than brakes of the description upon which the improvements are based. The invention consists in the employment of a longitudinal bar carrying at or near its ends arc-shaped brake shoes.

118. Improved Heel Trimming Machine.

This invention has for its object to furnish an improved machine for trimming shoe heels. The crank, by means of which motion is given to the machine, is attached to a shaft which revolves in bearings in the frame. To the shaft is attached a small bevel gear wheel, which engages with the large bevel wheel attached to a vertical shaft. To the upper end of the latter is attached a wheel, the edge of which is made in the form of a double cam, to allow the arm that carries the knife to move inward at the proper times. A screw rod limits the movement of the knife, and serves as a guide rod to hold the coiled spring by which the knife is held out to its work. The knife is made with a finger, which projects in front of its cutting edge and rests against the edge of the guide, which rests upon the top of the cam plate, and is secured detachably to the upper end of the vertical shaft. The guide is made of the exact form to be given to the heel, and must be changed with every change in the form or size of the heel. A short hook-rod on the arm enters a groove formed in the under side of the cam wheel, which groove is so formed as to cause the knife to move forward quickly to cut the elongated sides of the heel, and slowly while cutting the short curve of the rear part of the heel. A clutch grasps the top of the last directly over the heel, so as to hold the shoe-heel firmly upon the guide-plate while being turned and trimmed. In using the machine, the shoe is placed in position, and the crank is operated to give it a half revolution; the shoe is then removed, and the revolution completed to bring the machine into position to receive another shoe.

119. Improved Water-Wheel.

This invention relates to that class of water-wheels with which hinged or pivoted gates are used, and has for its object to remedy the difficulties arising from the manner in which the studs are formed and secured to the gates. The invention consists in the lug of a pivoted or hinged gate of a water-wheel, made with a vertical hole to receive the stud, and a transverse hole to receive the wedge-key; and in the cross-head stud, made with a transverse notch to receive the key for securing it detachably to the lug of the pivoted or hinged gate of the water-wheel.

120. Improved Method of Restoring Tinned Sheet Iron.

The vast number of tin cans used for preserving articles are considered worthless when emptied of their contents, and are thrown away by the million; but the iron which is tinned and used for these cans is of the first quality, or much tougher than ordinary sheet-iron, and much better adapted for many purposes when restored, especially for binding trunks, and for many similar purposes where pieces of large superficial measurement are not required. The object is to utilize these cans now thrown to waste; and this invention consists in the process of restoring the iron to its original state, but in small sheets, and thereby utilizing it. Tin melts at about 450°, but will not entirely leave the iron until subjected to a higher temperature. The iron is therefore subjected to a temperature of about 1,000°, or to a cherry red. This cleans off the tin and anneals the iron, rendering the latter very pliable, and adapts it for many purposes where toughness and pliability are essential. When the iron is taken from the oven the pieces are passed between rollers, which press upon it just sufficient to straighten it and prepare it for market.

121. Improved Rock Drill.

This invention has for its object to furnish an improved steam rock drill, which shall be so constructed that the valve may be shifted at the proper time to cut off the steam, and at the same time admit the steam in front of the piston, so that it may cushion itself upon steam and diminish the jar or shock, and in which the piston may turn, and thus turn the drill as it makes its up stroke. To the end parts of the valve stem are rigidly attached two discs, at a distance apart equal to the distance required for the throw of the valve, and an additional thirty-second of an inch, more or less. Upon the stem upon each side of the valve are placed pistons of such a length as to give the valve and two pistons a play of about a thirty-second of an inch upon the stem, between the discs. The diameter of the discs is made enough less than the diameter of the end parts of the valve chest, to allow the steam to pass the said discs freely. By suitable construction, as the piston comes to the upper part of the cylinder the lower port is uncovered, and the steam passes through it into the lower end of the steam chest, below the lower disc. As the steam enters the lower part of the steam chest it forces the discs, pistons, valve, and valve stem upward until the upper disc strikes its stop, and stops the forward movement of the stem and discs. The steam now passes around the edge of the lower disc and forces the pistons and valve upward until stopped by the upper disc. This movement allows the steam in the end part of the steam chest to exhaust through the exhaust. The exhausts are so arranged as not to be fully closed until the valve pistons and discs have nearly completed their stroke. By this construction the valve and its attachments and the piston will always move in the same direction, which lessens the jar, and consequently the wear, of the mechanism. A simple friction device is so arranged as to rotate the piston as it rises, but to allow said piston to descend without turning. The lower end of the piston rod is made hollow to receive the drill bit, and is slotted longitudinally to divide it into three or more parts, so that the drill bit may be securely held and may be conveniently detached when desired.

122. Improved Stitching Gauge for the Blind.

This invention consists of an improved stitching gauge for the blind, formed of bottom, front, and rear plates. In the upper part of the front plate is formed a horizontal slot through which the stitching is done. The upper edge of the rear plate is about upon a level with the lower edge of the slot in the front plate, and in the said plate are formed two vertical slots to receive the buckle bars, to enable the work to be held firmly against the slot in the front plate. In the centre of the bottom plate is a hand nut, through the screw-hole of which passes a screw, the upper end of which is rigidly attached to the platform, upon the lower edge of which the work rests when stitching straight work. The platform slides up and down along the inner side of the front plate, and is kept in place by grooved flanges. To the outer side of the front plate is attached a horizontal bar to prevent the gauge from setting too deep in the jaws of the stitching horse. To the outer side of the front plate is detachably attached a ratchet bar which has as many teeth to the inch as the work should have stitches to the inch. Upon the outer side of a slide, where the awl is to be inserted, is formed an inclined projection, against which the tapering forward end of the ferule of the awl strikes, and thus pushes the slide forward one tooth each time the awl is inserted. In using the gauge, when the work has been stitched the length of the slot, the work is moved forward until the awl strikes the other end of the slot, the slide is moved up to it, and the gauge is again ready for work.

123. Improved Cotton Planter.

This invention relates to the construction of cotton planters with a view to enable them to be easily and cheaply manufactured, while their efficiency is maintained or increased. It consists in improving the ordinary shaking hoppers, which have arms moved up and down by side studs on a wheel, so that the seeding operation may be easily and conveniently stopped and resumed.

124. Flame Extinguisher for Lamps.

This invention consists in making a very durable and compact joint of both spring and extinguisher with the movable arm of the latter by bending and riveting the end of the arm.

125. Improved Box Scraper.

This invention consists in a certain construction of stock and scraper, and means of attaching the same to each other, and to the handles, whereby a convenient and handy tool is produced.

126. Improved Windmill.

This invention relates to improvements in the class of windmills having vanes so pivoted that the force of the wind tends to turn them around it; and consists of a double crank shaft and a reciprocating sleeve on the post, on which the wheel frame is pivoted and around which it swings, so contrived that a connection is made with a pump rod, or two or more, if desired, on the side of the post, and the rod or rods worked thereby without hindrance to the turning of the wheel frame, and without any cramping or side draft.

127. Improved Hopper for Grinding Mills.

For automatically closing one spout, and opening the other, of a double or two part stock hopper of grist mills, it is proposed to have a right angled valve arranged between two discs, and pivoted at the angle under the middle partition between the two spouts, so that by a quarter of a revolution on the axis one spout will be closed and the other opened. The side which is open will be subject to considerably more pressure by the grain passing through than the one which is closed by the grain in the hopper above, so that it cannot shift until the hopper from which the grain is running is empty, when the weight of the grain in the other hopper will instantly open it by the weight on the side closing the spout. A bell is attached to the axle of the valve, so as to sound each time he valve shifts and changes the grists, to notify the miller of the change.

128. Improved Reel.

This invention consists in a reel, the arms of which are provided with dividing discs for separating the two parts of the skein, so that the silk or thread wound on such reel may be crossed in opposite directions in the spaces between alternate pairs of arms, in order that at such crossing each separate strand will be above its predecessor.

129. Improved Apple Parer.

This invention has for its object to so improve the apple parer patented by the same inventor on December 10, 1872, that the knife will make a positive stop until the apple has made one revolution. The invention consists in providing the gear wheel of the knife arm, at that point at which the knife takes its position for paring the apple, with two or more recessed cogs and a projecting tooth and lug extension, in connection with the pinion wheel of the crank shaft, having also part of the teeth cut off and provided with a circular flange, so that thereby a full stop of the paring knife is obtained while the fork is revolving once with the apple.

130. Improved Shoemaker's Pinchers.

This invention consists of a pair of shoemaker's pinchers, having the jaws in the same longitudinal plane and the teeth abutting against the turning face of the jaws, so as to bring the bite near to the pivot, and thereby not only to secure more leverage in the gripe, but thus to enable the upper to be drawn close to the last.

131. Improved Clothes Pounder.

This invention is an improvement upon the clothes pounder for which letters patent were issued to Ezra Pollard, December 28, 1858, and consists in a wooden block provided with a central vertical hole and with two circular concentric rows of holes, between which a circular communicating groove is formed to allow the air to enter and escape from the inner row of holes through openings in the outer row or in the side of the block.

132. Improved Parallel Ruler.

This invention consists in a main slide piece, with suitable set screws, moving in a guide frame carrying the adjustable ruler, and acted upon by a band spring applied to a wedge-like thumb-piece, which produces alternately, by the pressing and releasing of the controlling finger, the required parallel motion of the ruler.

133. Improved Stop Valve.

This invention relates to that class of stop valves for water, steam, gas, &c., in which one or two discs or gates are arranged in a chamber traversing the water way, and work transversely across the water way on the seat or seats, and are pressed thereon to close the water passage by means of the valve stem; and it consists of levers combined with the discs or gates and an enlargement on the valve stem in such manner that, when, in closing, the gates have returned to their seats, the levers and the enlargement come into play in such manner that they force the gates upon their seats with a powerful lever pressure, which is produced with the stem by the operator without much effort.

134. Improved Truss Bridge.

It is proposed to have bottom, middle, and top chords composed of three parallel timbers, with double posts framed or boxed between the timbers of the bottom and top chords, and passing between the timbers of the middle chord without boxing, and with braces firmly secured to the posts and the bottom chord, all in a manner calculated to produce very strong frames, capable of sustaining great weight in long spans.

135. Improved Pile Driver.

This improvement in pile drivers consists of an endless chain for raising the drop, working over a driving wheel at the bottom and a drum at the top of the frame, and

through contrivances on the drop, with which a lock and a trip are arranged, so that a weight causes the lock to engage the chain when the drop strikes, so that the chain immediately lifts the drop again, and thus saves the time lost in the ordinary pile drivers in running the hooks down to connect with it. The lock is tripped at the top of the frame, or at any desired intermediate point, by an arm coming against any suitable stop in the ascent of the drop. The invention also consists of a crane and hoisting rope combined with the driver and the driving mechanism in a simple manner, for raising a pile while another is being driven by the same driving gear by which the drop is worked. It also consists of a guide for controlling the head of the pile while being driven, contrived so as to be engaged with the rib guides, on which the drop works, after being attached to the head of the pile before it is raised up to be fixed in the machine.

136. Improved Cradles.

The first invention consists in two-part cradle ends, set apart and connected by intermediate springs. These springs, one at each end, raise the extension and body from the base, which allows the cradle or crib to rock back and forth on the springs, the rocking motion being limited to the width of the openings between the extension and the base. The same inventor has also patented another cradle in which there is a central pivot at each end. A flat spring at each extremity is attached at its ends to the iron rail of the body.

137. Improved Treadle for Sewing Machines.

This invention consists of a pawl and lever and a bell crank combined with the treadle mechanism of a sewing machine, in such manner that the operator can start the machine by a lateral movement of one of the knees, and thus save the labour of starting the wheel by hand. The invention also consists of a holding pawl combined with the balance wheel and a double crank, the object being to prevent the machine from being turned backward, to which a double crank is liable without a holding pawl.

138. Improved Washing Machine.

A board set on edge is designed to keep the clothes upon the opposite sides of the machine separate from each other. An upper roller is fluted longitudinally, and revolves in uprights. To it is attached the crank, by means of which the machine is operated. The lower roller is also fluted, and slides up and down in slots in the lower parts of the uprights. To the lower ends of the sliding bearings and to the upper edge of the ends of the division board are attached pins, to which are secured the ends of the U-shaped springs, by which the lower roller is held up against the upper one, so as to apply pressure to the clothes while passing through the machine. Four rollers at the inner corners of the uprights diminish the friction as the clothes are passing into and out of the machine.

139. Improved Saw.

It is proposed to divide the teeth of a cross-cut saw into groups of four teeth by a wide blank space of about one inch between, and in each group to have two teeth fronting one way and two the other, with their cutting edges formed at right angles to the longitudinal axis of the saw. The ends of the teeth are bevelled enough for clearance, and the cutting edges and ends shaped like a chisel edge by bevelling them on one side only. The bevelled sides are alternately reversed. At the heel of each rear tooth of a pair is a cleaner for scraping out the chips cut off by the teeth, said cleaner being an extension of the heel of the tooth as low as the point.

140. Improved Roller Clearer for Spinning Machines.

This invention pertains to an improvement in the construction of clearer rolls of spinning frames; and it consists in providing a covered roll with an enlargement, or, in other words, in reducing its diameter uniformly at every point except the centre. Thus constructed, only the enlarged portion will come in actual contact with the rolls of the spinning frames.

141. Improved Metal Planing Machine.

This invention has for its object to furnish an improved machine for cutting key seats in shafts without removing said shafts from their bearings. Two screws are swivelled in bearings attached to the four corners of the bed. To one end of the screws are attached bevel gear wheels, which engage with similar devices on a cross shaft to which power is suitably applied. The screws also pass through screw holes in a cross head that slides upon ways which are so formed as to cause the said head to move back and forth squarely, and to sustain the upward pressure of the tool, thus relieving the screws from any strain. To the crosshead is attached a block, the upper and lower sides of which are bevelled to form a way for another block. The side edges of the second block are bevelled to serve as a way for a third block, on the forward side of which is a T groove formed to receive the tool holder, through a slot in the forward end of which the shank of the tool is passed. By this construction the tool can be adjusted vertically and horizontally, and inclined to one or the other side, as may be required. Four set screws pass in horizontally through the side bars of the bed to receive and hold the work to be planed or dressed.

142. Improved Propelling Vessel.

This invention consists in the improvement of the class of boats which use suction wheels in the side of boat, drawing the water in from the side and discharging it at stern or bow, according to whether it is desired to go forward or backward. It consists in the peculiar means for enabling the boat to be backed, by means of a gate closing the channel through which the water is drawn to the rear, and opening a reverse channel through which the current is forced.

143. Improved Sash Holder.

The object of this invention is to furnish means for holding the sashes of windows in any desired position in the frame or casing; and it consists in the arrangement of a spiral or coil spring, acting upon the sector or wedge-shaped rack. By a slight upward pressure on the operating lever, the sector is turned and the wedge is moved downward and the sash released.

144. Improved Kerosene Heater.

The object of this invention is to furnish improved facilities for heating water and other liquids by means of a kerosene lamp; and it consists in two annular liquid reservoirs arranged around the lamp chimney. Two different kinds of liquids—as water and milk, for instance—may be heated at the same time. The heater is made of tin or similar material, and the chimney is riveted or soldered with hard solder so as to resist the effects of the heat.

145. Improved Ladies' Gaiter Shoe.

This invention has for its object to improve the construction of ladies' gaiters, so that there will be no seam crossing the instep; and it consists in having the vamp made in one piece with one of the half-quarters, and seamed to the other half-quarter, the seam commencing at the junction of the overlapping parts, and terminating in the shank between the heel and sole.

146. Improved Car Coupling.

This invention consists in the improvement of car couplings by combining the buffer spring with a rigid buffer bottom, having an upright plate and a sliding box, having partitions, to support the link in a new and convenient manner.

147. Improved Life Preserving Attachment for Railroad Cars.

This invention aims to protect brakemen on railroad cars, and consists in a foot piece and rail raised on a bracket applied to the top of cars, so that the brakesmen can pass from one car to another without damage to life or limb.

148. Improved Pen-holder.

The object of this invention is to furnish an improved pen-holder, which softens the scratches and jars of steel pens, producing an easy hold without cramping or tiring the fingers. The invention consists in attaching a hollow elastic sleeve to the stem of a pen-holder, so as to confine a quantity of air and form a cushion.

149. Improved Farm Fence.

This invention consists in the posts and pivoted or tilting bars for supporting a fence formed of wires or other material; in the combination of the loops and bars with the bars or posts which support the fence; and in the portable brace for strengthening an inclined fence against pressure. By this construction the weight of the panels forces the bars downward upon the loops, clasping the panels firmly between the bars with a greater or less force, according to the weight of said panels. The bars and loops may be used for connecting the panels to vertical posts, if desired.

150. Improved Rotary Engine.

The object of this invention is improvement in the class of rotary engines and pumps having a piston box placed eccentrically within the steam cylinder and controlling the piston arms. The piston arms are arranged concentrically with the steam cylinder and tightly fitted to it by means of springs and packing.

151. Improved Signs.

This invention consists in applying, to the backs of detachable letters, pivoted spring jaws or arms, which are adapted to be sprung under or into notches in a rod supporting the letters, said springs serving, in connection with hooked plates or clips attached to the letter and fitted on the rod, as a medium for firmly retaining the letters in position, while not preventing their easy removal when desired.

152. Improved Dovetail Machine.

This invention consists in the improvement of tenoning and sash dovetailing machines. This machine is mainly arranged like an ordinary tenoning machine. Next to a tenoning head is a cope head; next to a cope head is a dovetailer, which is set as close to cope head as it can be and run clear; it is mounted on a bar, which is pivoted to the machine in such a manner that it can be set perpendicularly, or inclined by swinging the bar on its pivot. Another dovetailer is set far enough to allow the check holder to tip over while passing between. The dovetailers are driven by belts from an upright shaft. There is also other improved mechanism of which a clear idea cannot be imparted without the aid of a drawing. To operate this machine for dovetailing sash stiles, the carriage is raised by means of inclines and screw, so that the sash stile, when laid on the carriage, will be above and clear of the head and cope; the upper head is then set so as to cut the stile to the required thickness; the dovetailer is then set so as to give the dovetail or diagonal cut, and another dovetailer is set so as to cut the last part of the dovetail mortise; then the stop is adjusted to give the depth of cut required; the stile is then put on the carriage against the gauge bar, and passed through, and is finished at each end by one operation. The stiles for the bottom sash are run with the face of the stuff down, and the stiles for the upper sash are run with the face up.

153. Improved Ice Cream Freezer.

To the tub of the freezer is connected the ice receptacle, which is made with a spout leading into the tub, through which the pieces of ice enter. The spout of the receptacle is provided with a gate to enable the outflow of ice to be regulated as required. A tube extending up allows the cold air from the ice to pass into the middle part of the receiver, so as to freeze the middle part of the cream as quickly as the outer parts. To bars crossing the open lower end of the tube and secured to the bottom of the receiver is attached a pivot, which works in a socket in the bottom of the tub. With the upper end of the tube is connected a vertical shaft which by suitable mechanism communicates with the crank for operating the machine. In using the freezer, the receiver is revolved by turning a crank with the right hand, and a spatula is controlled and guided with the left hand. The apparatus should be so arranged that the operator, while turning the crank with his right hand, can open the gate with his left hand to admit ice to the tub as required.

154. Improved Machine for Dressing Millstones.

A small rectangular frame is arranged, so that a platform, sliding forward and backward on a long frame, will carry the picks parallel with the furrows; that the shifting of the frames will adjust them from line to line for fine or coarse cracking; that by turning the pickstock the picks can be adjusted for cracking or furrowing; and that by shifting the socket-piece on the pickstock, the picks can be adjusted to the angle of the furrows, and by the fast and slow feeds the picks can be moved along the stone radially at the requisite speeds for the different kinds of work.

155. Improved Water Wheel.

This invention relates to modes of utilizing the reactionary power of water, and consists in buckets having peculiarly shaped curves; in a novel mode of applying adjustable gates; and in combining with the ordinary wheel a subjacent second one, which receives the reactionary impact of the water from the first, and utilizes it in a very effective manner.

156. Improved Tilting Gate.

This invention consists in the combination, with double main posts, of two folding half gates, which fold up into a vertical or inclined position, as may be required.

157. Improved Splice Joint for Railway Rails.

This invention consists in a fish-plate having a solid flanged base, that fits an excised part of the inside base flanges of rail, and rests, with an offset, upon a shoulder of the same to give strength to the rail ends, and cause them to last as well as other parts of the rail, and at the same time to take the strain off the bolts.

158. Improved Pruning Knife.

This invention relates to pruning knives, and consists in a novel mode of combining the parts to form a pruning knife which shall be simple, effective, and durable. It also consists in a peculiar mode of adjusting the relative position of the blades to take up the gradual wear upon them.

159. Improved Grindstone.

The object of this invention is to produce a perfectly true and central fastening for the cranks of grindstones, for the purpose of permitting their placing on and detaching at pleasure, economizing thereby in space and freight in shipping. The method provides a bushing cemented centrally to the grindstone, with a detachable crank. The different pieces may be separately packed, resulting in less damage to the goods and reduced expenses for freight.

160. Improved Hose Coupling.

This invention consists of a couple of short sections of metal tube, which couple together by a screw collar swivelled to one of them, and in connection therewith each section is provided with a clamp composed of two semi-circular parts connected together by flanges and bolts for clamping the hose on the metal tubes. The clamps are attached to the metal tubes by stud pins, which prevent the hose from slipping off the tubes endwise, and when clamped thereto by the ordinary two part metal clamps not connected to the tubes.

161. Improved Car Coupling.

The mouth of the bumper is made hopper-shaped, and with a horizontal opening between the inner edges of the upper and lower inclined sides of said mouth. The upper and lower inclined sides of a wedge-shaped cavity meet the upper and lower inclined sides of the mouth of the bumper head, just in front of the hole for the coupling pin, so as to form ribs, which angles serve as fulcrums to the coupling link, to allow its outer end to be raised to enter the bumper head of the adjacent car by lowering its inner end. The coupling pin passes down through a hole in the bumper, and upon its rear side is formed rack teeth connecting with a small gear wheel, attached to a rod. The rod passes through and works in holes in the flanges formed upon the upper side of the bumper, and which rise sufficiently high to protect the gear wheel. The ends of the rod extend out to the side of the car and terminate in a crank, or hand wheel. The lower end of the rack forms a shoulder, which rests upon the link, so that by turning the rod and gear wheel in the direction to force the pin downward, the inner end of the link will be lowered, raising the outer end of the said link to ad-

just it to enter the bumper head of the adjacent car. As the pin is raised, the outer end of the link will drop by its own weight. To the rod is attached a spring to hold the pin in any position.

162. Improvement in attaching Knobs to Spindles.

The spindle is made square, and has one, two, or more transverse notches or grooves formed upon the side of one end to receive the screw that fastens the neck of the knob. Upon the outer end of the spindle is cut a screw thread to receive the nut, the outer middle part of which is recessed to adapt it to serve as a cap to receive the neck of the other knob, which is secured to the spindle by a screw which passes in through a hole in the side of the socket nut, so as to lock the said nut as well as to secure the knob. A sleeve is slipped upon the socket nut to keep the screw from working out. The cavity of the rose is so formed as to receive within it the socket nut and sleeve and its outer end projects inward so as to cover the ends of the said nut and sleeve, and fit upon the neck of the knob. The inner side of the plate of the rose is recessed to fit upon a washer, interposed between the said rose and the side of the door, to prevent the door from being chafed by the said rose.

163. Improved Wrench.

This invention is an improved wrench for turning the nuts of fish plate bolts, and other nuts and bolts that require great power to turn them. The base of the improved wrench is of such a length as to rest upon three ties at the same time. To the middle part is attached a wide bearing in which a shaft revolves and slides. One of the projecting ends of the shaft is enlarged, and in its outer end is formed a square hole of sufficient size to receive the nut to be operated upon. To the other projecting end of the shaft is attached a chain wheel, which is so small that its rim will not come in contact with the tie or ground. An endless chain passes around the chain wheel and also around another chain wheel attached to a second shaft. By turning suitable screws the bearings may be raised to tighten the endless chain. Locking nuts are placed upon these screws, so that the two halves of the bearings will be held close together. To the second chain wheel is attached an arm, to the outer end of which is attached a bolt, which passes through a longitudinal slot in a bar, and is provided with a hand nut. The other end of the bar passes over the projecting end of the wrench shaft, and is secured in place. Upon the end of the bar is formed a handle for operating. The arm and slotted bar thus form an extendible crank, which may be conveniently extended and contracted to give a greater or less leverage as more or less power may be required. The machine may be inclined in one or the other direction, as may be convenient in operating it. By this construction, as the machine is operated to turn the nut in one or the other direction, the movement of the nut upon its bolt will move the machine out or in.

164. Treating Cotton Seed Oil to render it Drying.

This invention consists of a chemical treatment of cotton seed oil, to prepare it so that it can be used in the arts as a substitute for linseed oil. The inventor dissolves bichromate of potassa in water, heats to boiling point, carries into this clear cotton seed oil, agitating and mixing strongly for two hours; after twenty-four hours the oil is drawn off into another vessel, and here is added gradually, under constant strong agitation, *aqua regia*, freshly prepared, diluted with water. After settling the oil is again drawn off into another vessel, where it is mixed with oil of vitriol, diluted with water under agitation. It is then allowed to stand till clear enough for use.

165. Improved Harvester Cutter.

This invention consists of independent ledger plates for the cutters of mowers and reapers, secured to the fingers by a lip at each rear corner turned down on the edge of the finger, and a bar above extending along the whole series, and secured detachably to the front edge of the finger bar, so as to be readily taken off to remove the plates for sharpening them. At the other ends the plates are secured by a notch in the end, and a notch or slot in the finger, as in other cases.

166. Improved Waggon Seat Fasteners.

The object of this invention is to provide a fastener or latch, which is applied to both sides of a waggon seat, to connect the same firmly to the body of the waggon, so that the displacing or detaching of the seat is prevented, and a secure seat obtained. The invention consists of a hinge fastener combined with a latch applied to the sides of a waggon seat, the hinge fastener with bent end closing over the guide strip of the waggon body in connection with a pin locking into a hole of the same.

167. Improved Water Regulator for Boilers.

This invention consists, mainly, of the employment of a small tube or cistern by the side of the principal receiving cistern or vessel, into which small cistern the water is received and flows from it into the boiler, and in which is arranged a float having such connection with the cock for shutting the water off from the boiler that, when the water rises to the required level in the boiler, it will close the passage, and open it again when the water falls.

168 Improved Leg for Furniture.

This invention consists in constructing the legs of tables, desks, chairs, etc., in two parts, made and applied separately at right or other angles to each other at the corners, and fastened separately to the table or other article, and fastened together at the bottom by a kind of lock-joint, secured by a button at the top on the table.

169. Improved Disinfectant Compound.

This improved deodorizing and disinfecting compound is nitric acid mixed with oil of tar. This mixture is agitated with carbonate of lime. Sulphurous acid is caused to pass through, when, after settling, the fluid is separated from the solid parts. The solids are then dried, and, when reduced to powder, are fit for use. The fluid product is also very useful for pouring into sinks and other conduits requiring disinfection.

170. Improved Musical Railway Signal.

The object of this invention is to avoid the disagreeable and monotonous whistling of locomotive engines, and substitute therefor a more satisfactory method of signalling, and at the same time to indicate different signals by the combination of harmonious sounds, or by various successions of sounds. This object is accomplished by providing a series of whistles in connection with the steam boiler of a locomotive engine, so that one or more of said whistles may be brought into action by the engineer.

171. Improved Hoe.

This invention consists in an acute angled socket for attaching hoe blades to handles, the part or arm of the same which is to be secured to and cover the end of the handle being of semi-tubular form, and provided with an inner projection or lug, and the other part being flat, or nearly so, to adapt it to be applied to the back of the hoe blade, to which it is secured by means of rivets.

172. Improved Hoisting and Conveying Apparatus.

This invention consists of a portable apparatus, having a crank frame and roller frames, over which an endless chain is stretched, which is provided with adjustable links and hook carriages at suitable distances for hoisting and conveying the receptacles for the materials. Two of the roller frames are placed on the ground; two others are combined with the crank frame at any required height above the lower frames and connected by guides which convey the boxes to the place of work. The chain is so constructed that it can pass over the rollers, which have separate shafts and are placed at some distance from each other, to allow the passage of the hooks between them.

173. Improved Combined Brake and Propelling Mechanism for Cars.

This invention is an improvement in the class of apparatus for propelling and braking railway trains, in which air is forced into suitable receivers when the train is checked, and its expansive power utilized into subsequently starting or propelling the train. The operation is as follows:—When the train is running on a level, or when it is to be stopped or impeded by the brakes on down grades, so that all the steam is not required for driving it, the throttle valves will be closed, and air inlet valves will be allowed to act, thus converting the engines into pumps, which, being actuated by the running gear of the car, will force the air through passages into the receivers, which are connected together by a pipe, so that all may be filled to the extent of their capacity to retain it—say two hundred and fifty pounds to the inch; then valves will be fastened open to stop the pumping. At any time when more power is required than the steam is capable of exerting, the valves will be released so that they can close, and the throttle valves will be opened, thus converting the apparatus into a motive power, which, being impelled by the compressed air, will largely aid the overburdened engine in its work.

174. Improved Churn.

In this invention the body of the churn is hung between standards, so as to have a universal movement to adapt it to the dasher, which, worked by a crank, is provided with gearing, so that it has both a rotary and an up and down motion.

175. Improved Smoke and Steam Burner.

A box or trough, open at its top, is supported upon pivots attached to its ends, which work in bearings attached to the front and rear walls of the fire-box. The coal to replenish the fire is first placed in the box, where it is exposed to the full heat of the fire. This heat expels the more volatile gases, which, with the smoke, are at once ignited and consumed. At the proper time the box is tilted, and the coke is dumped into the fire, so as to replenish without checking it. A steam pipe leads from the exhaust of the boiler, or from the boiler, and passes through the fire upon the grate. The pipe is connected, by a hollow pivot or other convenient means, with a pipe which extends along the bottom of the box, and has numerous holes formed in it. By this means the steam is superheated while passing through the pipe, and is discharged among the coals in the box, where it is decomposed, mingles with the smoke and volatile carbon from said coal, and is consumed.

176. Improved Shutter Worker.

This invention consists of an improved device for connecting all the window shutters upon each row, or upon each side of a storehouse or other building, so that they may be all closed or opened at the same time, and from any floor of the building upon which the operator may happen to be.

177. Improved Chair Seat.

This invention relates to an improved mode of forming seats, backs for chairs, settees, etc. Strips of wood are placed edge to edge, and the ends enter grooves in the inner edges of the side bars of the frame. The forward edge of the forward strip and the rear edge of the rear strip enter grooves in the inner edges of the front and rear bars of the frame. The adjacent ends of the bars of the frame are framed and secured to each other in the ordinary manner. A strip of galvanized iron, flat or a wire, is passed through holes in the strips, and its ends enter and are secured in holes in the front and rear bars. One or more of the metal strips may be used as may be required.

178. Improved Fireproof Floor and Ceiling.

The joists are made of wood and form abutments for brick arches at the top or for the floor, and so as to support inverted arches for the ceiling or bottom. Braces of iron may be used for tying the joists together, the design being to keep the joists rigid and at a uniform distance from each other. A succession of arches forms the entire support of the floor. These arches are sprung from one joist to another, with bricks made for the purpose, supported by the bevelled surfaces or abutments of the joists. The floor may be of any description. The lower part of the joist has bevelled surfaces, which support the arches. The bricks which form the arches come in contact with each other and form a continuous incombustible surface beneath the joists. The plaster or ceiling surface is laid directly upon the arches, thus dispensing with laths.

179. Improved Combined Spade and Fork.

The object of this invention is to adapt a fork to be used as a spade; and consists in a sheet metal sheath or pocket adapted to receive a fork and be secured thereto. When the fork is inserted in the sheath, a ring on the handle thereof is slipped down over projections, and thus the sheath is secured to the fork, and the same is thereby converted into a spade.

180. Improved Tire Shrinker.

This invention consists in a new mode of shortening tires by means of a slide bar gauge and hook lever, which enable the work to be done very effectually as well as very quickly. The mechanism is easily and cheaply prepared, and withal not liable to get out of order.

181. Wood Filling.

This invention relates to a compound for filling wood previous to the application of paint or varnish, and consists in a preparation, which is entirely devoid of colour and will not therefore change the characteristic hue of the wood, which can be applied with an equally favourable result to all varieties, and which permeates so thoroughly the pores and fills so completely the interstices between the fibres that a single coat of varnish or paint will be generally sufficient to produce the designed outside face upon the wood.

182. Improved Washing Machine.

This invention consists in a machine possessing in an eminent degree three essential elements of a good washing machine, namely friction, pressure, and concussion. The lower roller being comprised of polygonal rolls, each of which has an independent movement, a greater amount of friction is produced than by a cylinder composed of round rolls. The shape of the rolls results in carrying the materials under the pressure roller, instead of drawing or pulling them under, as is the case with solid rollers composed of round rolls, thereby preventing the clothes from stretching or being torn, or in anywise injuring or interfering wih buttons, buckles, etc. It is also much easier to operate than any other machine now in use, as it requires less power to carry materials under the pressure roller than it does to drag or pull them under the same, by the kind of motion common to the kind of rollers now in use.

183. Improved Cotton Press.

This invention consists in providing with a gravitating cover the press box, and winding it up by a windlass mechanism; in supporting the follower on the outside end of the press box upon a wheeled carriage; and finally, in the peculiar construction and location of the press box.

184. Improved Ice Casket.

This invention relates to burial caskets for preserving the bodies of deceased persons until it is convenient for their friends to bury them, and consists in providing, between the body receptacle and casket, a pipe connection through which the air may be exhausted; also, in applying a rubber lining to the inside of the casket and cover to exclude all air from the outside.

185. Improved Car Coupling.

This invention is an improvement upon the coupling for which letters patent were issued to A. Pritz, March 25, 1873, and consists in forming a right-angled slot or recess in the side of the coupling or catch, and a right-angled notch in its forward edge to adapt it to be held in place, and also guided in its movements by a short cross bolt projecting through the side of the drawhead.

186. Improved Paint Compound.

This invention relates to a new composition for paint, whereby the paint is held perfectly in solution without settling, combining the pigment and oil, producing a glossy and consistent covering for the preservation of woodwork and other bodies, and effecting a considerable saving in the pigments employed. The solution is prepared by dissolving bicarbonate of soda and borax in water. This is then mixed with dry oxide of zinc, linseed oil, and benzine, and thoroughly ground together, producing a glossy, cheap, and durable paint compound, which may be used as body for any desired shade or tint by adding the necessary colour to it.

187. Improved Terret and Martingale Ring.

This invention consists of a fluted roller and pawl to be used in the terrets and martingales in substitution of the ordinary check rein rings for guiding and controlling the reins; also for aiding the driver in controlling the horse by turning freely with the rein when pulled backward by the driver, but not turning in the other direction, so that when the horse gets advantage of the driver he must also overcome the friction of the reins on the rollers.

188. Improved Trace Buckle.

This invention consists in a trace buckle in which the tongue is pivoted and provided with a lock. As the trace is passed forward the tongue enters the hole therein, and as it draws back it pulls the tongue plate into the angular recesses in the lugs of a plate, and thereby locks the same. This movement of the tongue is effected by slots in the plate. With this buckle the trace is kept straight and smooth, without cracks or wrinkles.

189. Combined Fender and Ash Sifting Attachment.

This invention is a combined fender and ash sifting attachment, to be used in connection with an ordinary fire-place fire-grate, for the purpose of separating the ashes from the unburnt pieces of coal that fall from the fire-grate, so that the latter can be readily replaced upon the fire freed from ashes.

190. Improved Car Coupling.

This invention relates to automatic car couplings wherein the link lifts a catch hook by its own forward movement, and consists in attaching said hooks to a bar pivoted at the rear end, held down by a spring and lifted by a vertical rod. It also consists in a novel and effective mode of raising the lift rod.

191. Improved Cotton Bale Tie.

This invention relates generally to bale ties, but particularly to that class consisting of a strap of thin metal having one end turned into the form of a hook, and the other end broadened into a transversely slotted eye-piece provided with a side stop at the outer end of the slot. There has been experienced, practically, with these bale ties a good deal of difficulty in turning the band after it is tightened sufficiently to secure the hook and eye together, while there is necessarily more or less play of the hook in the eye afterwards, which causes the sleeve to become displaced, and the bale to become loose and even untied. The invention consists in the peculiar mode of arranging and constructing this eye-piece so that it can be easily inserted within the hook of the strap and be securely held, with or without the sliding sleeve or loop which is sometimes used.

192. Improved Composition for Waterproofing Wall Paper.

This invention has for its object to furnish wall paper which shall be so prepared that, when applied to the wall in the ordinary manner, the papered wall may be washed, and which will leave the colours upon the paper wholly unaffected. The invention consists in first dissolving white soap in warm water. When fully dissolved, white wax and isinglass are added and the mixture stirred continuously until it boils. When fully cold it is ready for use. To apply the mixture, the paper is spread upon a smooth table, and the former is applied with a soft brush, care being taken to cover the paper evenly by rubbing it well with the brush. The paper is then rubbed with a dry brush to give it a gloss.

193. Improved Glove Fastening.

This invention consists of a little bar with a series of notches in each edge and wide portions between the notches, hinged to a clip fastened to the glove at one side of the slit for the wrist, and a notched hook on a clip fastened to the glove at the other side, so arranged that it can engage the bar behind any one of the enlargements to fasten the glove tight or loose, as may be desired. The clips by which the bar and the hook are fastened to the glove consist of thin plates of silver, gold, or any ductile metal, with spurs formed on them, to fasten them to the glove, by punching them out of the metal in the ordinary way of making such fastenings.

194. Improved Ice Shaving Machine.

This invention furnishes an improved machine for attachment to the counter in soda-water and other salons for shaving the ice. The forward parts of the downwardly projecting sides of a hopper are cut away to allow a tumbler to be placed beneath said hopper to receive the shaved ice. In the lower part of the hopper is placed a small cylinder, to which are secured a number of knives or cutters, rotated by a crank. The piece of ice is placed in the hopper, rests upon the cylinder, and is held down by a plate which is placed upon it, and which is attached to a lever. The lever passes through slots in the hopper, and its forward end is pivoted to a plate which slides up and down in a groove. The latter plate may be raised and lowered to adjust the position of the lever and plate according to the size of the piece of ice to be operated upon. The rear end of the lever projects so that the operator can grasp it in one hand to hold the ice down with the requisite pressure while he operates the crank with the other hand to shave the ice.

195. Improved Insect Powder Gun.

The object of this invention is to provide a commercial package for insect powder, which may also be used as a gun or ejector for discharging the powder into crevices, &c., at the same time that the cost will not be much more than common packages. The invention consists of a cylindrical box, of light and inexpensive material, and a short piece of flexible tube joined together at one end, the paper or wood box having a cap at the other end, and, by preference, a hopper-shaped bottom at the end connected to the flexible tube, with a small hole for the powder to pass from it into the said flexible tube. The latter has a small nozzle through which to eject the powder by compressing the tube, the nozzle being detachably connected so as to pack the packages economically. The hopper bottom is employed to retain the mass of the material in the paper or wood box in which it is packed and deliver it into the flexible ejecting portion in small quantities as the box is shaken.

196. Improved Steering Apparatus for Vessels.

The object of this invention is to construct for river and ocean vessels an improved steering apparatus, by which the power transmitted to the rudder is equalized, and the same more fully within the control of the helmsman. The invention consists in the hinge connection of the tiller with the rudder post, together with a supporting guide arm of the same. The nearer the tiller approaches the centre, the quicker turns the rudder post, so that the rudder moves rapidly when in position at either side of the axis of the vessel, where also less power is required. On the approach of the tiller to a horizontal position, the rudder moves with decreasing speed but with increasing power, as the pivoted arm relieves the strain on the steering rope by supporting the end of the tiller.

197. Improved Composition Filling for Painters.

The object of this invention is to provide for carriage manufacturers an improved "painters' rough stuff," which is put on after the paint, and leaves a smooth and solid surface after rubbing. It consists of a mixture of pulverized pumice stone and white lead, thinned by coachmaker's japan and rubbing varnish. The wood is first filled with from three to five coats of keg lead, and then coated with this surface protector, which causes the work to take a fine polish.

198. Improved Cotton Bale Tie.

This invention consists of a small S shaped bar for tying the bands and cross ribs on the bands, both lower and upper sides, at short distances apart near the ends, which are fastened together. This is effected by inserting the band in the notches of the aforesaid bar, one part on each side, in a very simple manner.

199. Improved Straw Cutter.

This invention is an improvement in the class of straw cutters having feed rolls, one of which is adjustable vertically, and yet so geared with the stationary roller as to continue its revolution, whether they are separated by a small or large quantity or thickness of the material to be cut.

200. Improved Tool for Seating Bung Bushes.

This invention has for its object to furnish an improved tool for bevelling the bung-hole of a cask and counter-sinking said hole to adapt it to receive a bung bush. The body of the tool is cast hollow, and of such a taper as will give the desired bevel to the bung-hole. In one side is formed a recess to form a seat for the knife cutter, in which, directly opposite the edge of the cutter, is a slot for the chips to escape through. Around the upper edge of the tapering body is a flange of a breadth equal to the desired breadth of the countersink of the bung bush. Upon the upper side of the flange are formed two projections, one of which is so arranged that its face may be nearly flush with the edge of the flange, so that the cutter attached to said face and the cutting point may project below the flange to cut around the edge of the countersink. The other projection is arranged across the flange so that the cutting edge of the cutter may project through a notch in the flange to cut the countersink. Upon the upper edge of the body is formed a rigid ball, having a socket formed upon its upper part to receive a handle, by means of which the tool is operated.

201. Improved Saw Swage.

This invention consists of an improved attachment of a saw swage, by means of which the swage will be held perfectly square across the tooth, so as to make all the cutting points exactly alike, and thus enable the saw to be filed much more quickly than it could otherwise be done. The invention consists in the guide arms connected at their upper ends by a back, and pivoted to the stock of the swage. The guide arms are provided with a set screw which passes through one of said arms and screws into the other arm, so that the lower ends of the arms may be adjusted closer together or farther apart, as the thickness of the saw plate may require. By using the swage upon the teeth of a saw partly filed, and then filing the teeth by the marks of the swage, it is claimed that the saw may be filed in less than half the time that would otherwise be required.

202. Improved Inside Blind.

The invention has for its object to improve the construction of Venetian or inside blinds, and it consists in the arrangement of an upper roller, carrying front and rear ribbons, attached to the slats of the blind, and provided with cords for suspending the same, so as to enable the blind to be lowered and raised from the top. This, together with the angular adjustment of the slats, is effected by turning the roller. The vertical movement of the slats from the bottom is accomplished by elevating cords. The invention further consists in a novel method of attaching the slat-shifting ribbons to the latter, dispensing with the use of rivets, staples, or other fastening devices, and insuring, also, a more perfect closing of the slats; and it consists in passing or looping the ribbons through slots near the edges of the slats, so that when the latter are in a vertical or closed position the edges of the same will abut more perfectly than in ordinary blinds.

203. Improved Paint-Brush.

This invention is intended to furnish ready and convenient means for raising and discharging paint and similar substances which are applied with a brush, through the brush, so that the fluid may be readily spread by the operator. The invention consists in a rubber syringe and flexible tubes provided with suitable valves, and arranged in the handle of the brush. A tube conducts the liquid from the reservoir to the apparatus.

204. Improved Plough.

This invention consists in the construction of ploughs, so that the plough-plates may be secured firmly to the standard without bolts, and in such a way as to present no unevenness for the soil to catch upon, and which will enable the plough-gate to be quickly attached and detached. It consists of a lever brace, pivoted at its rear end to the slotted lower end of the plough standard, secured at its forward end detachably to the plough beam, and provided with a shoulder or pin for securing the plough-plate detachably to said standard.

205. Improved Spark Arrester.

The cinders and sparks are deflected by an inverted cone (the upper parts of the stack) drawn through a perforated flange, and ascend and pass through a circular opening, and then strike a horizontal disc, and are thrown in each direction. They are still further retarded before they escape by an interior flange around the top of the hood. Before reaching this point the sparks or cinders are broken up, so that when they escape from the hood any fire which they may retain is instantly extinguished by contact with the atmospheric air.

206. Improved Reed Organ Swell.

The design of this invention is to make a clear and open passage for the escape of the sound from the reeds through the case of the instrument; and it consists of a movable board or outside swell in the case, with a suitable connection with the ordinary swell, or the lever which operates it, to be opened by or with the said ordinary swell, and allow all the sound waves a clear, open, straight passage through the case, whereby a large gain of power is obtained without any extra exertion on the part of the player, at any desired time, giving nearly double the effect of the front reeds.

207. Improved Carpet Lining Machines.

This invention relates to a combination of revolving screens, carding cylinders or scratchers, and feeding and condensing rollers, the object of which is to receive the cotton, flock, or other fibrous material from a willow or breaker, form it into a smooth lap of uniform thickness, and deliver it between sheets of cloth or paper, which form the upper and lower surfaces of the complete fabric, and confine and secure the lap. The inventor, we believe, is the originator of carpet linings made with one or more continuous sheets of paper or cloth, united together by mucilage, or sewn. The capacity of the machines is claimed to be 5,000 yards per day. Mr. Harrington has taken several patents on the same subject, but he asserts that the invention now under consideration is preferable to any other.

208. Improved Railway Rail Chair.

The main object of this invention is to prevent the ends of the rails of railroad tracks from being battered or damaged by passing trains, and it consists of a cavity or recess beneath the joint of the rails, whereby a certain degree of elasticity is allowed the ends of the rails.

209. Improved Manufacture of Boots and Shoes.

The object of this invention is to provide an improved clamping connection of textile or other fabrics with hard and unyielding materials, as wood or composition soles, &c., so that shoes or other articles of manufacture may be produced quicker and cheaper by means of machinery, and the hand labour hitherto necessary for such work be dispensed with. The invention consists in grooving the wood sole or other material at the upper edge, and binding the fabric, by a suitably shaped metallic clamp, firmly thereon, so that a strong and intimate connection of the parts is obtained.

210. Improved Printing Press.

This invention consists in gearing the sliders with the frame of the press, also with the reciprocating type bed, to maintain the proper relation of said sliders to the table at all times, and prevent the overrunning of one by the other, which now happens in consequence of the irregular action of the bed on the sliders, caused by the pressure of the cylinder on the bed when going one way and the freedom from pressure when going the other way.

211. Improved Rubber Shoe.

This invention consists of india-rubber boots and shoes, the uppers of which are made considerably thicker and stronger at the junction with the sole than at the top and in the upper portions, and gradually lessening in thickness from the bottom upward. In carrying out the invention, dies are sunk in the rolls, by which the sheets for the upper portions of the shoes are made deeper in the parts in which the lower portions of the uppers are formed than in the parts whereon the upper portions are formed, and thus the required variations in the thickness are produced at the same time that the sheets are made.